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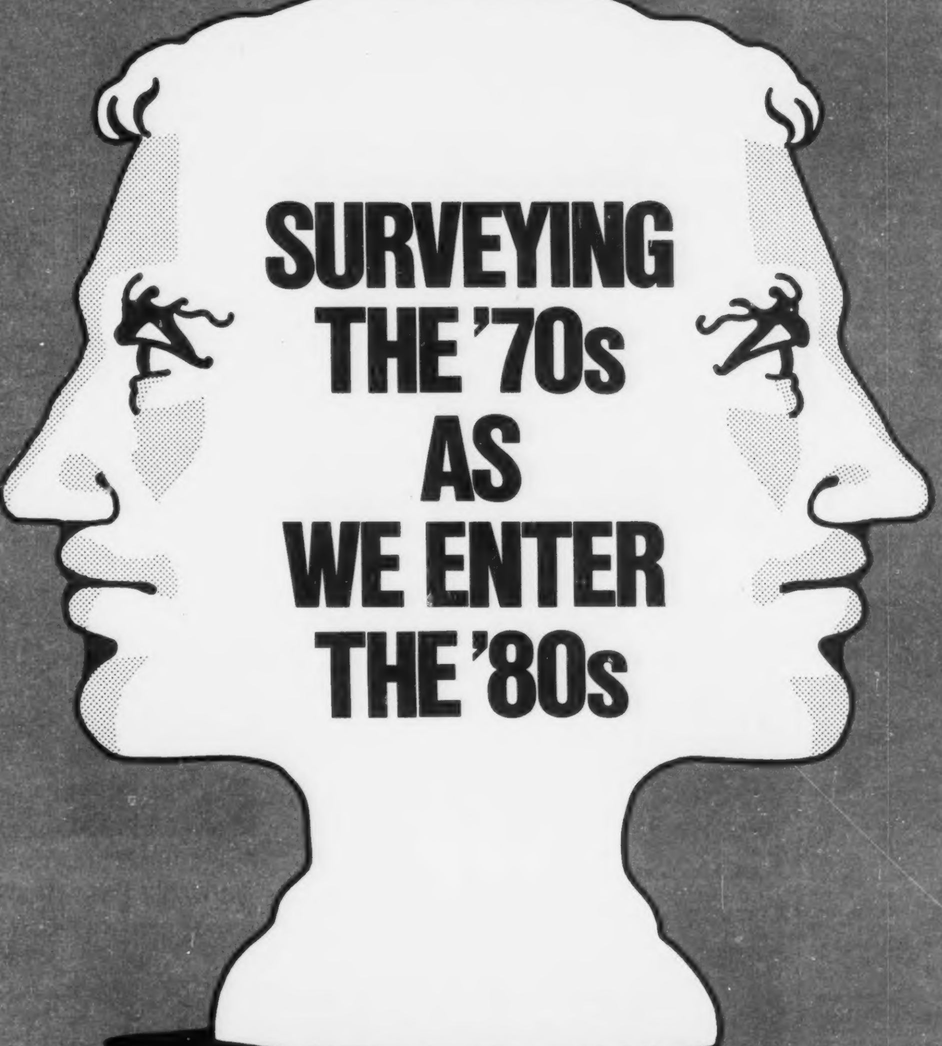
SURVEYING THE '70s AS WE ENTER THE '80s



We have reached a unique moment. The past is too recent to be the good old days, and the future too far off to be entirely clear.

Yet, at this juncture of the decades, we can glimpse the shifting patterns of technology and ideas.

Hardware developments of the '70s are yielding to the software promises of the '80s. Expensive machines grow cheaper. Inexpensive ideas experience newfound wealth.

And DP managers are courted by companies desperately searching for the Midas touch of the true professional.

The machines of the '70s become the antiques of the '80s. They grow bigger, more powerful; we, in proportion, feel smaller. We question their limits — and ours.

Now, having smashed the technical and financial barriers to the widespread use of powerful computers, we must confront the cultural consequences of our creations. What will the '80s bring? What questions asked, what answers found?

Take a look for yourself . . . inside.

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SURVEYING THE '70s AS WE ENTER THE '80s

1990

A VISION OF THE FUTURE

By Earl C. Joseph

Computer systems and technology developments for the 1980s are expected to split along a multiplicity of lines, both revolutionary and evolutionary. There is increasing evidence that future computer systems will be more evolutionary in nature in the early 1980s but far more revolutionary in the late 1980s and 1990s.

Many factors, including rapid semiconductor technology advances, movements into very large-scale integration (VLSI) and very high-speed integrated (VHSI) circuits, smart machine applications, office-of-the-future trends, further application diversity and widespread proliferation resulting from considerably lower cost hardware, suggest the forcing of a multiplicity of changing patterns. That is, the future of computers will be largely technology-driven.

However, forecasts based solely on the technological superiority of new and/or rapidly advancing technology could be grossly misleading. Many societal forces for further change or stability — the energy crisis, growing worldwide political pressures and competition, new government policies and regulations, management and public acceptance of change — all point toward altered patterns of rapid technological change. In other words, many nontechnological considerations share in influencing the course of future computer developments.

In turn, such nontechnological trends directly impact the course in which technological innovation will be encouraged or discouraged to develop. In the main, however, many nontechnological considerations often, in retrospect, can be shown to be technology speed-up factors — as in the case for the opportunities spawned by the many applications resulting from the energy crisis. Conversely, nontechnological problem considerations, in the short range, can considerably slow the introduction of technology and systems.

The new computer revolution, measurable in picoseconds, submicrons and component systems, can be forecast to develop even faster in the 1980s. We are at the threshold of a new "knowledge processing" era that will go far beyond the previous information processing and data processing eras now under way.

Opportunities and Problems

Some new directions for computers were initiated in the 1970 decade — microprocessors, the silicon (chip) revolution and the office-of-the-future are but three from a long list. In the 1980 decade, new ground will be broken as the computer field revolutionarily bifurcates along some new directions.

However, a number of negative social aspects of computing are currently impacting future computer design. Some are:

- Experts required.
- Errors and faults (hardware and software).
- The "creating unemployment" myth of automation (displacement of people problems).
- High cost of hardware and software.
- Invasion of privacy.

Each of these and others are creating, once a computer system is designed and in use, problems and taboos. If ignored, they will cause certain publics to react adversely against computers — and in some cases cause laws to be passed limiting or controlling what can be done with computers (and how).

In turn, as these problems become visible to computer designers and managers applying computers, systems will tend to be designed to avoid or eliminate their future possibility of occurrence (Figure 1).

Trends in Technology

Almost from the beginning of transistor usage in the modern computer era, an unbroken trend has been maintained for significant improvements in hardware technology and the price/performance of each computer system introduced. Advancements in the fundamental semiconductor technology are expected to continue throughout the 1980s along the trend trajectory started in the early 1960 time frame, which became well established in the 1970s (see Figures 2 and 3).

Therefore, measurements of the coming decade, using this technological advance pipeline as a yardstick, point to tremendous change — and further proliferation of computers and their usage, resulting from continued technological-driven price erosions together with computer system performance enhancements. The capabilities and application of semiconductor chips 10 years from now will go far beyond what is currently being anticipated by most engineers.

Extrapolated trends of some expected short-range future revolutions (Figure 2) and long-range future computer developments are shown (Figure 3) together with a look at forecast computer/microcomponent complexity trends.

The four short-range future computer revolutions, shown in Figure 2, now visible for the 1980s, are mapped as to their expected leading edge of occurrence, major characteristics and the resulting impacts for society

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and computer systems. They are:

1. The component processor revolution, beginning now (1979-80), starts with providing a basic building block for computers and communication systems, next generation LSI and VLSI hardware, intelligent machine products, people amplifier appliances and digital automation for embedding in other machines to make them smarter. Eventually this will result in such components also becoming end products.

2. The component computer revolution predicted to start in the 1981-83 period (with early trial versions in 1980), provides the basic component for systems, made from VLSI and VHSI hardware, with a progressively larger component computer evolvable throughout the decade. It will be the era of universal (rather than general-purpose) computer products and hard program products, leading to intelligent data management systems and communications subsystem components. This development causes most computers to become components.

3. The component memory revolution forecast for a 1983-85 introduction kicks off with a basic memory building block for information systems, distributed memory, a system component for revolutionizing communications, information appliances, a smart data base computer and knowledge-based systems. This results in memory becoming components and could allow offices and schools to become portable machines sometime in the 1990s.

4. The component systems revolution, forecast for a 1985-88 introduction (with special applications early in 1980-81), is initiated with silicon wafer component systems which further revolutionize institutions, leading to the possible demise of mainframe computers and allowing factories to become machines in the 1990s. It will be the era of "system on a wafer" technology, communications will offer substitutes for travel and buildings and the forecasted information society will emerge. Thus is future technology predictable.

A Flip-Flopping Time

From macrosystems to microsystems, an economy-of-scale (EOS) flip-flop: components become end products, machines/computers become components and factories/offices become machines. These major technological transitions, now techologically feasible for the 1980s, portend significant long-term impacts on society and future computer systems.

Computer evolution is increasing tenfold every decade (see Figure 3), chip technology is increasing 100 times per decade while innovation is going at 1,000 times per decade. What will happen to chip technology when it "crashes" into the computer curve? Will it bend toward the computer curve or will computers move onto the technology track?

The answer is yes — to both questions!

New directions in microsystem technology will result in cybernetic machines: intelligent machines; people amplifier devices with para-expert adjuncts; information appliances; and microfactories or distributed factories.

This latter point needs elaboration. Imagine a future cookie farm. The smart (computerized) planting machine loosens the land ultrasonically (or with short bursts of microwaves) and then sows rows of wheat, oats and sugar beets. The seeds will be specially encapsulated, containing moisturizers to face any drought situation but moisture-inhibited to withstand a downpour. When the field is full of reapable crops, along comes the computerized microfactory machine (the seed capsules, incidentally, will be time-programmed so the diversified crop matures at the same time, making such a harvest possible). The crops pass through to the processing part of the machine where they are crushed, mixed and baked, chocolate chips are added and the cookies are then processed, packaged and palletized.

A future history map from the 1980s also brings human cybernetic people amplifier appliances, knowledge-based system and robots. In the 1990s, we can expect even smarter machines and world-linked robots and people amplifiers; in the next century, perhaps "slaves" for robots!

Such technology advances offer the process for manipulating societies of the future.

Safe predictions for the next phase of semiconductor integration developments include VLSI and VHSI passing from tens of thousands of logic gates per chip into and beyond the 100,000 range — perhaps even by the midpoint of the 1980s decade. The ever-present

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WANTED

DP Professionals for the '80s

WANTED: 50,000 Programmers

This was the heading of a *Fortune* magazine article in 1967, but the message still holds true today. I predict that programmers will be in short supply throughout the 1980s, and that all the problems inherent in a labor shortage will continue.

Nothing short of a massive recession or a major educational effort will alter this outcome. Long-term changes are necessary if the future is to differ significantly from the present. But short-term needs will preclude such changes.

There are three major reasons why short-term needs will absorb most of our efforts: the inertia of software developed over the past 30 years, the pressure to implement new applications and the continuing shortage of well-trained computer professionals.

Thirty-Year Inertia

We feel the inertia of 30 years in a number of ways. For instance, running on current-generation equipment are numerous programs that have progressed from unit record equipment to first-generation computers to second-generation machines and so on without any significant rethinking of the fundamental systems design underlying the applications. As each program moves to a new computer generation, it carries forward the "baggage" of the previous generation, often even by direct emulation. At the time of each move, it was probably believed that the cost of redesign was excessive, and besides, the needed staff was not available.

It has been argued by Kendall of IBM that, since the lifetime of a very large percentage of computer programs is quite short, the "quick and dirty" approach to programming is frequently appropriate. This is fine if those programs that turn out to have long lives are reprogrammed. However, the resources for reprogramming are never available.

Thus, most programs are written using techniques intermediate between the "quick and dirty" and the great care appropriate to designing a program that will be used for a decade or more. The result is an excessive requirement for maintenance, which in turn takes people away from the important tasks of reprogramming or, worse still, the rethinking of the basic system approaches.

The lifetime of a major production system is typically on the order of 10 years. Thus, decisions already made will govern many of the applications of the '80s.

A good example of this is the U.S. Air Force "Phase IV" base-level DP support proposal presently being considered in Washington, D.C. It is based on earlier phases dating back to the early '70s and is intended "to provide a safe transition of current applications software and responsive computer support, growing as needed for up to 20 years [1983 to 2002]."

This example may appear extreme, but I wonder how many users of large centralized data base systems such as IBM's IMS will consider moving to other systems in either the near or medium term. This is especially true when, as is ever more often the case, the very life of the enterprise in question is dependent on the continuous operation of its computer systems.

New Applications

The pressure to install new applications comes primarily from economic considerations. Sometimes the new application will enable an existing function to be performed at lower cost. Other times the new application will enable new functions to be undertaken. Both factors may be fueled by the activities of competitors.

Encouraging the rapid development of new applications are the vendors of computer hardware who need to promote new applications in order to sell their ever more cost-effective equipment. After all, a vendor's business does not grow if the buyers only replace existing equipment with lower cost equipment and do not expand their applications.

The effects of inertia and the pressure to implement new applications could both be overcome if there were a sufficient number of suitably trained people to undertake the necessary work. Unfortunately, data processing is bedeviled by what Professor Hamblen of the University of Missouri-Rolla has very aptly called "the overutilization of undereducated people." Without the necessary number or needed quality of people, it is inevitable that short-term priorities get the attention to the exclusion of longer term needs.

From the mid-1960s to mid-1970s, our educational institutions were expanding at a rate that seemed to ensure an ample supply of trained personnel. Unfortunately, the growth has started to level off, and the National Center for Education Statistics projects an annual production of computer science graduates in the mid-1980s of approximately 11,500 B.A.'s, 6,000 M.A.'s and 470 doctorates.

These numbers are far below Hamblen's estimates of the numbers required to meet the needs of growth, attrition and upgrading. The continuing shortfall is also well illustrated by the "want ads" in the papers of almost every city in the country. To be more quantitative, a recent survey of 289 installations by McLaughlin of Trans Telecommunications Corp. found an average vacancy rate of 17% for applications programmers, systems programmers and systems analysts.

Recruiting, Training

Considering the shortage of people, one would expect employers to be making massive efforts to recruit the available computer science graduates. This is not the case, although computer science graduates have no difficulty getting jobs. Employers seem to be more interested in raiding each other than in taking in good material and providing on-the-job training.

This tendency can be attributed to three reasons – the lack of time to provide training because of immediately pressing work; the fear that the new people, once trained, will be pirated away; and the general skepticism in business of the ready usefulness of the education given in computer science programs.

It has been suggested that the ready availability of low-cost computer power in the '80s will allow the substitution of machine power for human effort, and hence the requirement for good technical people will be diminished. To some extent this will be true.

Certainly, compilers, report generators, data base management systems and so forth have significantly reduced programming time at the expense of computer time. I question, however, whether the availability of cheap CPU cycles will really take care of the three problem areas just discussed.

Net Impact

Does this mean that nothing will change on the personnel front? Of course not. There will be lots of changes, but my point is that the changes will be offset by growth and other factors, leaving many of today's personnel problems still with us in 1989.

Although not in the number required, there will be an inflow of better educated computer science people into the field and they will have an impact. This will probably be most noticeable in the area of program products, both systems and applications. In turn, this should encourage the wider use of such program products, thus releasing in-house programmers and systems analysts for other tasks.

A second important change will be the maturing of the first and second generation of better trained DP personnel and their move into more senior

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The personnel shortage of the '70s will continue as long as employers prefer raiding each other to hiring good people and training them.

By Bruce Gilchrist

management positions. This should raise the level of management understanding of the sometimes very complicated technical alternatives. Hopefully, this maturation will bring with it more realistic budgeting of people, money and time for DP projects.

Another significant change will be in the requirement for DP management to base decisions not only on strict dollar cost/dollar benefits, but also on less tangible factors. We are already seeing a growing awareness of the need to include disaster planning as a factor.

In the '80s, the impact on employment — both quantitative and qualitative — and similar factors will also have to be considered. This will require broader based managers and systems analysts. Along with their technical expertise, they will have to have a knowledge of and sensitivity to societal issues.

Communications Arena

No discussion of change can ignore communications, and it goes almost without saying that there will be a continuing demand for systems analysts and other DP personnel skilled in the various aspects of telecommunications.

In the recent McLaughlin survey referred to earlier, the greatest vacancy rate, 27%, was found in data communications. The vacant positions will be filled by the best people available. However, I fear that the best will not be good enough and, like batch processing in the '60s and '70s, our online systems of the '80s will be based on too little good thinking and too much on the "we've got to get the job done some way" philosophy.

Is there a chance that my pessimism is misplaced? I hope so, but I think not. The best we can look for is a much more serious attempt by the big industrial and commercial users to improve their relationships with the educational institutions. They should not attempt to coerce the colleges and universities to meet the short-term needs for Cobol programmers, but work with them to develop people who will really make a difference as they enter the DP work force in the '80s.

I am convinced that there is plenty of course material that would be appropriate to future commercial DP experts and also perfectly respectable from the academic point of view. However, the two parties must work together to get results.

At the risk of appearing self-serving, I would also suggest that industry consider spending a small percentage of its DP expenses on encouraging academic computer science programs. The investment in the future might well pay big dividends.

I recognize that my suggestion of industry-university cooperative efforts will not appeal to the "got to learn it in the real world" type of manager. But pause a minute and consider two questions. First, has the "real world" done that much to improve the level of competence of DP personnel over the past three decades? Second, is there an alternative? To do nothing is to abdicate the future to the whim of chance.

Despite my pessimistic outlook on the possibilities for major breakthroughs in solving our DP personnel problems during the next decade, I can end on an optimistic note. The decade to come will pose many challenging problems — more than enough to keep all competent DP people very, very busy. Add a continuing stream of new equipment to the mix, and we can all look forward to an exciting and stimulating decade.

'One Nice Feature on the CP 7000 Series Computer Is the Built-In Cattle Prod That Activates Automatically Whenever an Operator Falls Asleep.'

Data Communications Forecast for the '80s

A new and advanced mix of communications services is in the offing, tying together corporations of the future in public and private networks.

By Dixon R. Doll

The ending of a year traditionally provides many industry professionals with an impetus to back away from the hurry-scurry of the daily operational environment and look toward some of the issues likely to be of major impact in the years ahead. Similarly, it has become traditional to categorize the historical stages of our industry into phases in which new technology, functional system capabilities, user behavior patterns and regulatory trends have been predominant.

As we look to the '80s, there will certainly be many new thrusts driving the computer industry. Many of these are described in companion articles in this special issue.

However, certainly one of the biggest thrusts of the 1980s will be a continued demand for all types of communications — related services and systems. The need for a full menu of communications-related services and networking products from all industry suppliers has never been greater — and will grow virtually without limit in the foreseeable future.

The only barriers to this growth will be the constraints imposed by the substantial changes which such growth requires organizations to make. The most successful organizations in the communications environment of the 1980s will be the ones best capable of managing and digesting the changes which are certain to occur. These changes will come in many areas, including technology, user behavior patterns and new applications which can profitably be exploited.

What are the major communications-related developments likely to take place in the '80s which will contribute to the shaping and structuring of the industry in that time frame? Let's explore them.

In my travels within the U.S. and to other countries, I continue to discuss with both user and vendor organizations what they perceive to be the biggest problems in the industry today. While there is substantial disagreement on many issues, there is virtual unanimity about the single most important problem we in the computer industry face today — application development productivity.

Many studies have shown that if the U.S. is to continue programming computers and developing new applications at its present rate of productivity, it will require more than 50 million programmers and systems analysts by 1985! In fact, this lack of application development productivity with traditional centralized networking configurations and historical high-level languages has been one of the driving factors behind the distributed data processing revolution.

There is such a severe need for improvement in application development productivity that end users have taken matters into their own hands and begun to insist upon substantial functional capability directly at their local sites.

Communications Consequences

The communications consequences of application development productivity problems are simple. To provide an end-user organization with the right mixture of function distribution, processing power and distributed data resources at the locations where they are required, substantial communications capability must be an integral part of the selected networking and distributed processing approach. No vendor aspiring to the distributed processing marketplace dares to ignore the need for substantial enhancements in its communications offerings as we move into the 1980s.

Viewing the problem in a somewhat different perspective, the lack of good communications capability has been responsible for some of the most severe application development productivity problems which we have encountered in the 1970s. Without layered network architectures, application development programmers and end users have themselves been forced to become "experts" in networking, thus impeding the pace with which new business applications can be designed, developed and successfully cut over to operation.

Similarly, the task of providing ongoing support for these network-dependent kinds of applications — to make the simple changes associated with terminal additions, line reconfigurations and other day-to-day environmental modifications — requires substantial personnel and software resources. This must change in the future!

The Importance of Standards

Equipment incompatibility has been one of our industry's curses over the past decade. The countrysides are littered with networks whose vendors were not capable of providing sufficient intelligence to support the mixtures of terminals and applications which contemporary customers require. Much of the blame for this problem can be put on the lack of adequate communications standards.

In order to address the incompatibili-

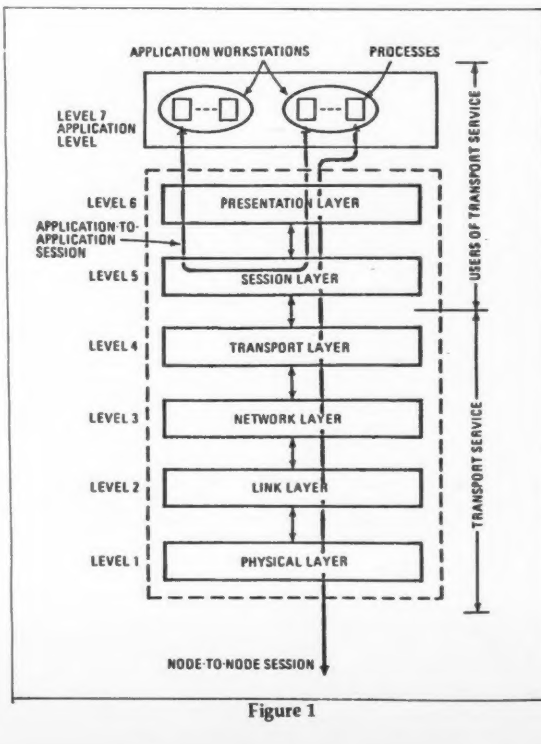

Figure 1

Dr. Dixon R. Doll is president of DMW Group, Ann Arbor, Mich.

ties between systems, computer communities and governments around the world have begun to participate in the development of the International Standards Organization's Open System Architecture for Distributed Processing Systems. As shown in Figure l, this effort is concerned with standardizing the protocols or rules for communicating between end points of a distributed processing network and between adjacent functional layers, regardless of the particular vendor providing the equipment and processing power.

Users should follow the developments of the Open System Architecture standards very carefully; they will have a major influence on the offerings which are likely to become available during the 1980s. As shown in the figure, four of the layers of function are concerned with *transmission* of information (called the transport layer) and the higher layers are concerned with *processing-oriented* protocols which must be implemented at the end points of the distributed processing system.

As we enter the 1980s, Layers 1 through 3 have nearly been agreed upon by all of the participating organizations involved in the standards activity. In fact, the widely discussed CCITT X.25 protocol which emerged during the 1970s constitutes the specifications for the first three layers.

Layer 4 will probably become reasonably well standardized within the next three or four years. However, I think it will be much more difficult for the International Standards Organization to reach full concurrence among all of the conflicting interest groups for Layers 5, 6 and 7. It probably will be possible for the standards organizations to achieve industrywide agreement on partial functions associated with these layers.

One example of this would be in the development of protocols to support a virtual terminal. A virtual terminal capability will result in all complying network implementations using a standard format for transmission between the terminal and an application program, as well as standard rules for setting up the session (performing the log on), implementing required security functions and so on.

Then, in the individual end nodes, layers of function will be provided by the vendors to convert from the standardized virtual terminal formats to the device-dependent properties of their own environments.

In this way, broader interconnectability will be stimulated and the incompatibility problems addressed.

Carriers vs. DP Vendors

In the last several years, anyone watching the shaping of the industry has seen the common carriers begin to express interest in providing functions traditionally obtained from the DP community. Certainly the reverse is also true: DP vendors have begun to move more and more into carrier-related businesses. In fact, the seven-layer model of Open System Architecture is an accurate way to portray the battlefields on which the functional conflict between the carriers and DP suppliers is being fought.

Over the short term, it is reasonable to expect that Layers 1 through 4 will primarily be provided the common carrier types of organizations. Layers 5, 6 and 7 will continue to be provided primarily by the DP suppliers. such as the minicomputer, distributed processing and mainframe vendors we know today.

However, by the middle 1980s, we are likely to see substantial broadening of the potential overlap area as organizations like AT&T and the foreign postal, telephone and telegraph (PTT) administrations begin to offer complete networking capabilities that include the functions most appropriately considered to be in Layers 5 and 6.

In fact, in many foreign countries, where the governmental influence on the common carrier industry is very pronounced, there may even be some attempted participation by the carrier organization in providing the DP machines of the distributed processing network which perform the application-dependent protocols at Layer 7.

In summary, users can be sure the networks of the 1980s will be extremely intelligent. They will be designed to provide virtual connections between all the different resources which must be interconnected.

The standards which are utilized for designing these networks will, to a great extent, be influenced by the Open System Architecture model which is presently being developed. However, there will continue to be substantial political difficulties in getting all of the different interest groups to agree on the details of many of the

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And Now, Fifth-Generation Supercomputers

By Michael R. Clements

To remain competitive, mainframe systems of the future must carefully balance reliability, performance and cost. How a computer manufacturer scrambles to meet these goals will probably determine its viability as a contender in the marketplace of the 1980s.

The race to build a fifth-generation supercomputer for the next decade and beyond has begun in earnest and, as the industry nears the finishing line, only those competitors that have selected the right combination of technical and marketing strategies can be expected to run in the money. The key to success, therefore, is going to lie not only in how tomorrow's high-performance machine will be built, but why the final alternatives in design were chosen.

Although this article reviews the philosophy and methodologies Amdahl Corp. has used to develop its own 470 series computer systems, as well as a description of what to expect in the future, it also serves as a point of reference with which to compare the progress of the industry as a whole.

A Matter of Economics

In general, it can safely be said that the same characteristic philosophies that led to today's third- and fourth-generation computers will lead to the development of future generations of computers. The approaches are varied and reflect the influences of both technology and economics.

For those whose product line extends to mainframes of more than one size (medium- and large-scale systems, for example), the economic way to go may be to choose a technology that will be used across the entire line of computers. The trouble with this approach is that a design suitable for one class of computer will probably handicap the performance of another class. For instance, a manufacturer's highest volume segment may lie in mid-range computers and, for economies of scale, components will be designed accordingly. Use of these same components, though, in higher performance, large-scale machines may result in increased CPU circuit complexity in order to obtain faster instruction processing rates. In turn, the need for more circuitry extends CPU cycle time, creates excessive heat dissipation problems and adds to testing complexity.

Design philosophies may also reflect a certain attitude toward customer need. As an example, one company may feel that a market exists for a system with virtually no downtime. Since such reliability is only possible with redundant system configurations, the user really pays for two computers in one — and at a proportional increase in cost.

Other companies rely on the "safe" concept of reverse engineering for their marketing strategy. After copying the successful system of another company as the basis of its own system, however, the reverse-engineering firm may find that the strategy is not so safe after all. What seemed like a good market was really good only for the originator.

Still others rely on cutting costs as an operational philosophy. One way of doing this is to buy totally off-the-shelf components and assemblies to build a system. Unfortunately, unless there is a decided advantage in system architecture or circuit design, the entire computer system reflects the off-the-shelf capabilities of its components. It should be pointed out that most computer companies today design their systems around off-the-shelf rather than customized components and assemblies.

Amdahl Approach

At Amdahl, development of a totally new product, designed from the ground up at the beginning of the 1970s, eventually led to the world's first large fourth-generation computer. Encompassing a unique combination of high technology, innovative design and simplicity, the first 470 designs had a profound impact on the market because of a high motivation to get the product out of the laboratory and into the hands of the user. In this way, the technology always remains fresh, usable and highly competitive.

Perhaps the most important elements in Amdahl's design philosophy are reliability, performance and cost, each following in priority. Although all computer firms attach a certain importance to each of these elements, they do not always follow the same priority. At Amdahl, if there is a trade-off between reliability, performance and cost, reliability will always be chosen first, then performance and then cost.

The advantage of starting a company based on totally new design concepts and no prior product commitments, however, is that these three elements can be carefully balanced from the start, with a minimum of compromising. For example, to increase CPU speed performance, Amdahl engineers made the circuits simpler; at the same time, this not only reduced cost but significantly improved system reliability. The result was an LSI raw gate speed of 500-to-600 picosec and a total CPU cycle time as fast as 26 nsec. This not only resulted in greatly simplified field maintenance and repair procedures, but a physically smaller system requiring less floor space and cooling apparatus.

Innovation and Simplicity

The area Amdahl chose to innovate was that of the CPU. If one looks at a third-generation CPU, it is easy to see why the unit was slow, bulky, hard to test and less reliable than Amdahl's fourth-generation CPU. Starting with dozens of dual in-line packages (DIP) containing integrated circuits (IC) mounted on a printed circuit (PC) board (see Figure 1), a single CPU back panel might contain as many as 60 to 70 PC boards and then be inserted into a panel frame and interconnected with other back panels through miles of wire harness.

Amdahl, on the other hand, brought the CPU into the fourth generation with a revolutionary new design. After reducing an entire DIP-loaded PC board to fit onto a 13-layer, 100-gate, high-speed emitter-coupled logic (ECL) IC chip, Amdahl replaced the back panel with a proprietary multiple chip carrier (MCC) containing as many as 4,200 logic gates.

Primarily a 10-layer PC board, the MCC measures 7.4 sq-in. and contains up to 42 IC chips. Utilizing another unique design technique, some 80% of the total signal connections are made without wires through the use of 10,000 plated-through holes in the MCC that interconnect each of the 42 chips (there are 84 leads per chip) with one another and a series of top-mounted terminating resistors and decoupling capacitors. This is accomplished by configuring six of the internal PC layers (according to the basic CPU circuit design) as signal carriers, each path of which is brought out to a chip, resistor or capacitor lead — or one of 800 external I/O pin leads — via a plated-through hole. The remaining 20% of the signal connections are made through single- or twin-lead 4-mil wire.

Once an MCC is assembled, it is placed in a 3-MCC high by 7-MCC wide matrix CPU gate that is in turn housed in a 72-in. long, 63-in. high and 30-in. wide frame. Housing a total of 42 MCCs (21 on each side), the CPU gate nearly distributes a 30A-current density to each MCC and provides all MCC interconnections through 50-mil coaxial wire filled with an expanded Teflon foam dielectric that allows a signal propagation velocity of 1.25 nsec/ft. Behind each MCC, each coax (there are approximately 12,000 wires) is routed via the shortest possible length and is connected to a terminator card that matches the impedance of the cable. In turn, a 100-pin I/O connector is mounted to each card.

In effect, the entire frame-mounted backplane array of the third-generation CPU, including all wire cabling and associated I/O cards, has been replaced by a much smaller, faster and more reliable MCC CPU gate. Not only does this approach simplify making engineering and design changes, but each component in the entire gate can be individually probed and tested — unlike a standard edge-mounted PC board, which must either be removed or, for dynamic testing, interfaced with signal-distorting card extenders in order to be tested.

A Cool Performance

As a result of Amdahl's high-density LSI packaging and the selection of ECL gates for high-speed performance, a cooling system was required that could remove large amounts of heat from a small area. Although conventional wisdom at the time almost mandated the use of liquid-cooling systems (water or freon refrigeration is used in most competitive systems today) it was concluded, after much experimentation, that air cooling, properly designed, would be more than adequate for even the most advanced 470 computer.

At the present time, a push-pull fan system is used to provide airflow through vertical columns of MCCs, a bottom fan for air supply and a top fan for its removal. To solve the problem of differential heat dissipation, especially from chips and resistors at the sides and top of the vertical air column, a special air straightener (collimator) was designed, assuring good velocity distribution and eliminating air torque from the fans.

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Although the Amdahl LSI package required the removal of four or five times more heat per package than anyone had tried to deal with before, the air-cooling system was found to adequately handle as much as 3.5 W per chip without serious degradation. To bring the heat out from the IC chip into the air stream, a molybdenum stud was fabricated with the same coefficient of thermal expansion as the alumina ceramic carrier to which the IC chip was bonded. Mounted against the ceramic carrier on the side opposite the IC chip, the stud was fitted with a three-fin, gold-plated heat sink, further extending the cooling capability.

Recent tests have indicated that by enhancing the fin arrangement of the heat sink, increasing the airflow over the fin surfaces and possibly changing the materials used to fabricate the chip carrier and cooling stud to those with better thermal conductivity, the air-cooling system would be able to more than double the heat dissipation per chip.

Mastering the LSI Slice

Amdahl's strategy in designing its 100-gate LSI bipolar chip (there are some 1,200 transistor and resistor components per chip) was to come up with a "master" configuration that would require a minimum of masking and diffusion steps, thus saving cost while achieving higher levels of performance. With the master slice concept — which, incidentally, is beginning to be used throughout the industry — a chip is divided into cells, each containing the same diffused components. By suitably designing metallization layers to interconnect the various components, a total of 12 basic circuits are obtained.

In this way, only 10 costly diffusion masks are required, yet high-density performance is still achieved by completing the chips using three unique metallization masks for each of the different chip types. Typically, a 470V/6 contains some 2,000 LSI devices built around only 110 different chip types. Therefore, instead of having to generate more than 1,400 lithography masks (as is the case with many costly customized IC chips), Amdahl can get away with less than 400 masks. This economical method of obtaining high-performance, high-density LSI chips solved only part of the problem, however. In an Amdahl system, about one-third of the propagation delay is in the IC gates, one-third is in the packaging and one-third in the interconnecting wiring. An improvement in each of

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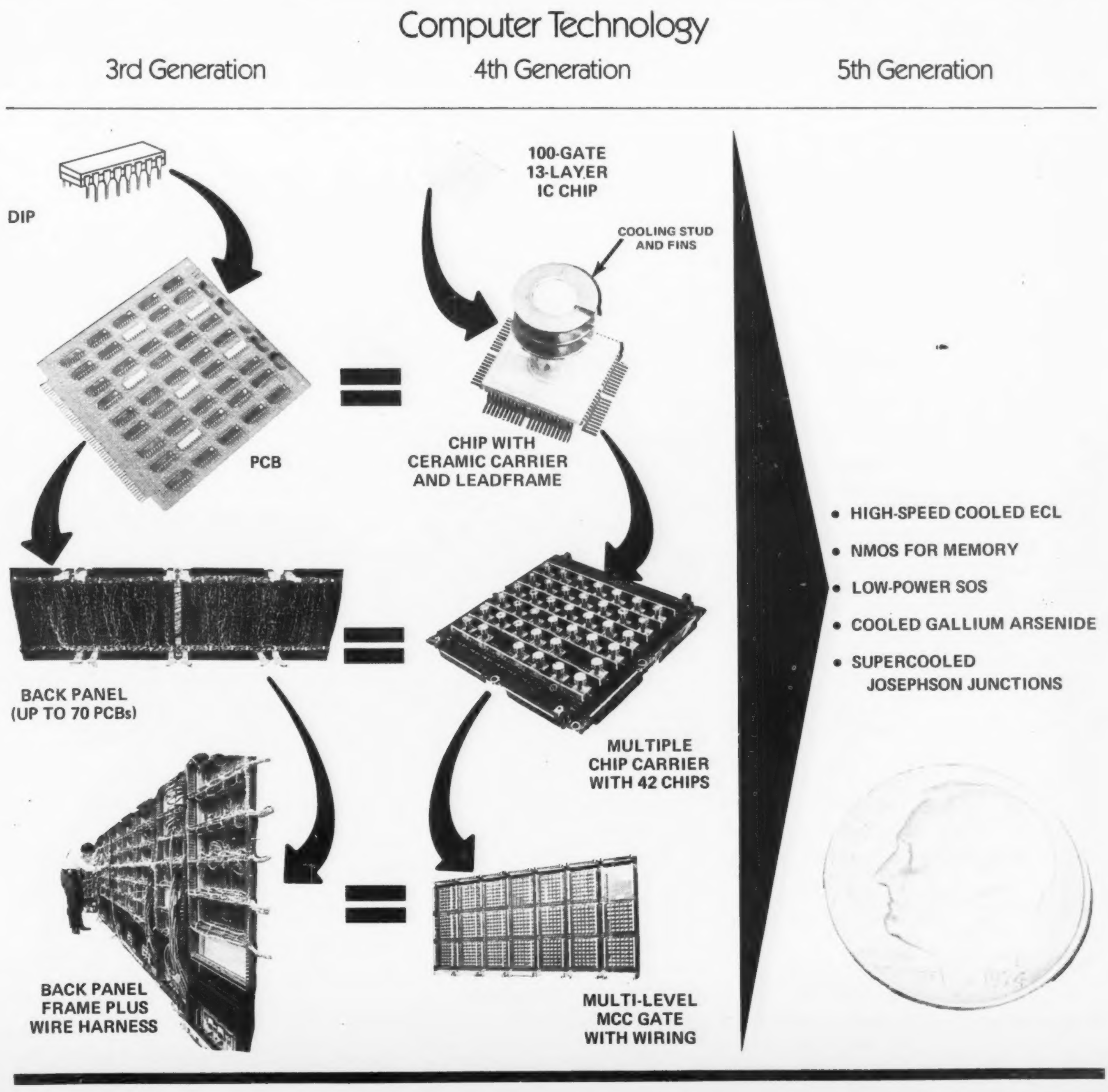

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these is needed to achieve faster overall system operation.

At the MCC level of packaging, one of the reasons for using up to 1,200 discrete wires was to take advantage of the fact that signals travel faster through a wire than in PC traces. The interconnecting wiring between MCCs is done in random point-to-point array so that the shortest physical distance is

'Just to keep up with today's marketplace is to become mediocre, and the pace in the coming decade is expected to become even more accelerated.'

used for each signal. In addition, the special coax wire using Teflon foam dielectric provides substantially faster signal propagation times than the usual twisted pairs, tri-leads or flat cable.

Aside from lower cost, greater reliability and faster speed, there are several advantages to Amdahl's approach to LSI design. For one, it becomes easier to make engineering changes in the design, since Amdahl anticipated the need to develop sophisticated design automation tools for this purpose.

A TECHNOLOGY PROJECTION OF THE LATE 1980s

	ECL	NMOS	CMOS/SOS
• RAW SPEED (FAN-IN/FAN-OUT=3)	100 ps	500 ps	900 ps
• CHIP CROSSING DELAY	400 ps	1600 ps	2000 ps
• DELAY PER FAN-IN/ FAN-OUT SENSITIVITY	LOW	HIGH	HIGH
• RISK	MEDIUM	MEDIUM	HIGH
• POWER/CHIP	16 W	16 W	1 W
• GATE DENSITY PER CHIP (8-MM SQUARE)	5-10K	20-30K	18-25K
• CHIPS FOR AN AMDAHL 470V/8-SIZE COMPUTER	20-40	6-13	8-15

For another, diagnostics become easier, since a complete 470 system contains a maximum of 60 MCCs (in addition to the CPU, the I/O channels and storage control unit use MCCs) and a failure needs to be isolated to one out of 60 MCCs rather than the more than 1,000 PC boards of a third-generation computer.

It should be mentioned that, owing to the proprietary wiring technique required on an MCC, experts had warned us to expect an excessive failure rate. However, these predictions have proven fruitless, in large part because of the Amdahl-developed computer-controlled fabrication and testing equipment used in bonding and testing the leads.

While Amdahl does not manufacture its own LSI chips, it does carry on a continual program of prototype R&D. In addition, we make our own masks and design our own testing equipment. Furthermore, all wire bonding and fabrication beyond the initial chip packaging stage is done in-house.

Independent Diagnostics

Other concepts utilized in the 470 system are so advanced that many consider them fourth generation in comparison with other systems. For example, built into the operator console is a minicomputer designed to enable an engineer to examine as many as 17,000 latch points throughout the system during operation. With such a dynamic, in-depth view of the system, diagnosis of faults can be performed with a minimum of downtime, a luxury unavailable in most other systems.

And in the case of a system failure that is beyond diagnosis at the user site, the Amdahl Diagnostic Assistance Center (Amdac) — located at headquarters in Sunnyvale, Calif., and in London — can be placed on-line 24 hours a day through a telephone modem from anywhere in the world.

The telephone data connection, between the console minicomputer and similar systems installed at each Amdac location, allows technical specialists and design engineers to function as if they were at the computer site, assisting the on-site personnel in the diagnostic process.

> *'In many respects, this analysis of the Amdahl 470 is really a precursor of some of the strategies many will take during the 1980s. Indeed, a few have already begun the transition.'*

In many respects, this analysis of the Amdahl 470 is really a precursor of some of the strategies many will take during the 1980s. Indeed, a few have already begun the transition. The trend toward higher density LSI chips is becoming extremely popular as is the move toward faster technologies (in both logic and packaging) and the acceptance of the master slice and built-in diagnostics.

But pioneers can't escape the lure of pioneering! Just to keep up with today's marketplace is to become me-

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diocre, and the pace in the coming decade is expected to become even more accelerated.

We at Amdahl believe that there will be three primary technologies predominant at the end of the next 10 years. For high-speed machines, ECL will become the leading technology, but with even higher performance characteristics. For memory components and in applications where power is a critical factor, NMOS will continue its present role as a major semiconductor technology. And in applications where power is the most vital prerequisite, a technology such as silicon-on-sapphire will probably present the sought-after breakthrough.

In ECL technology, it is perfectly feasible that speeds will improve by a factor of six or even seven — down to switching speeds of 100 picosec or less. But there are other things to consider when dealing with computer design. Chip crossing delays are much

(Continued on Page 16)

THE DO-IT-YOURSELF TERMINAL FROM IBM

You can swivel the screen and angle the keyboard to accommodate your needs.

The do-it-yourself IBM 3101 display terminal. You choose from two basic configurations, which range in price from $1,295 to $1,520. You set it up and quickly learn to operate it by yourself. You can swiftly diagnose and correct many malfunctions yourself. You order the 3101 with just one phone call and, for the character-transmission models, get delivery as fast as 60 days after you sign the contract. To top it off, you get the high quality, performance and dependability you expect from IBM.

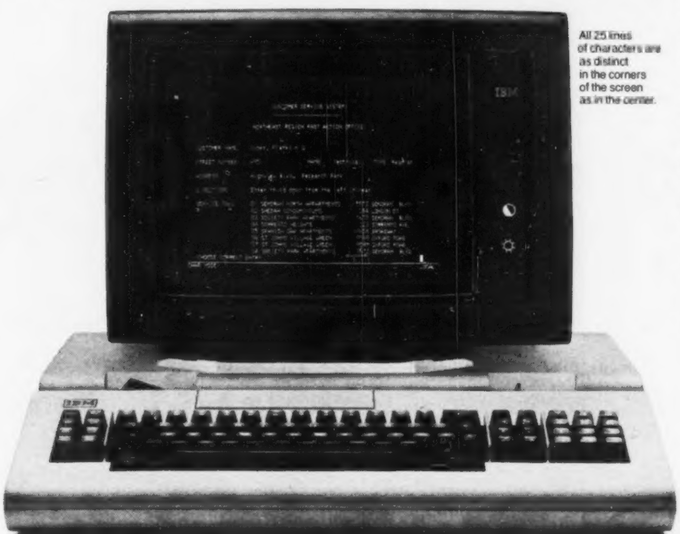
Save up to 20%

Volume procurements can save you up to twenty percent for either of the two configurations of the IBM 3101. One configuration, with character transmission, lets you use it like a teletypewriter. The other has selectable character or block transmission. In block transmission, it provides sophisticated editing capabilities such as insert/delete and full cursor control, along with field functions like blinking, high intensity and protected fields.

A convenient ASCII terminal

Accessible setup switches allow do-it-yourself selection, such as line speed, parity, scroll and reverse video. And since the IBM 3101 weighs only 38 pounds, it can easily be moved to where the work is.

Both models, which can generate all 128 ASCII characters, are ideal for most interactive applications and may be used with an IBM or non-IBM computer. And these terminals are even more versatile when used with our new 3102 buffered printer.



All 25 lines of characters are as distinct in the corners of the screen as in the center.

Human engineering inside and out

The 3101 lets you decide what's best for you. The 12-inch diagonal screen can be swiveled and tilted to cut interference from overhead lighting. Display the maximum of 1,920 characters in 24 lines and you'll see they're as distinct in the corners as in the center of the screen. For your viewing comfort, with the flick of a switch you can select green characters on a black background, or black on green. And there's a detachable contrast-enhancing filter to reduce glare.

The keyboard is moveable, so you can angle it to the screen to suit your comfort and eyesight.

The keyboard looks familiar because it's much like the IBM Selectric.* The 87 keys include a numeric keypad, graphic character keys, cursor positioning controls and dished home-row keys for touch typists. And the keytops are textured to reduce glare.

Diagnose malfunctions yourself

The terminal is designed to help you troubleshoot problems. The cause of equipment failure is displayed on the screen, using the twenty-fifth line. If you then follow simple instructions, you can generally isolate the source of the problem and correct it. If the equipment has a malfunction that can't be fixed in this way, the modular design of the 3101 lets you replace any of the three elements – video, keyboard and logic – while you send the faulty element to an IBM repair center for prompt service.

Out of the carton and into operation

Setup is do-it-yourself. You place the video on top of the logic element, connect the keyboard and video element and plug in the 3101. Then you simply use the appropriate setup switches to select the desired mode of operation.

Do-it-yourself printout too

You can also get a copy of the information that you see displayed on the IBM 3101 with the all-new IBM 3102 printer. A small, quiet, non-impact buffered printer, it attaches to the IBM 3101 and is just as simple to set up. You also get diagnostic functions so you can troubleshoot the IBM 3102 printer yourself. The purchase price for this printer is $1,[illegible]5, which makes hard copy economical. And ask about our volume pricing.

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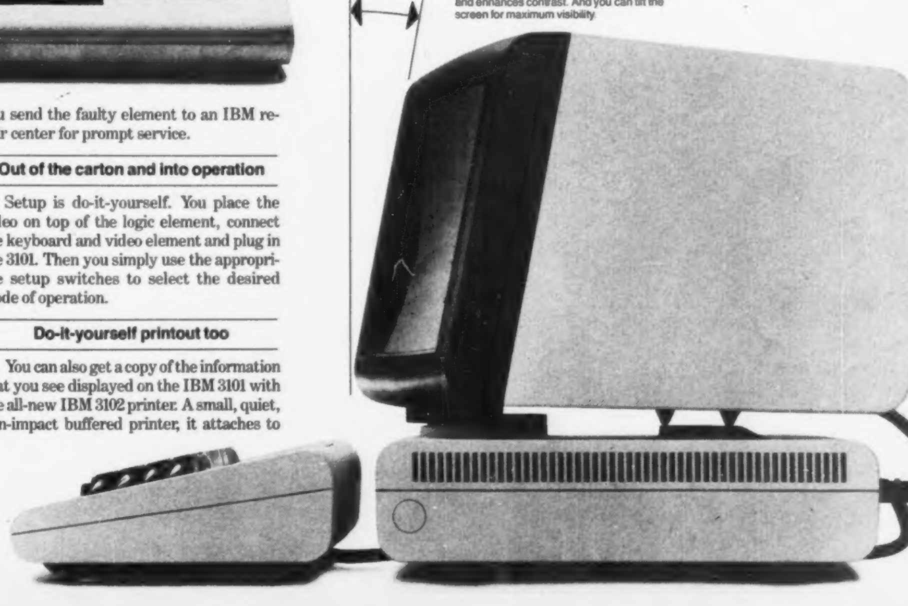

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less with ECL because of its high current driving capability; in fact, it is about four times better than NMOS. The delay caused by more than one signal — fan-in/fan-out —refers to the number of input signals that come into a given gate and the number of gates driven by it. In ECL, the fan-in/fan-out sensitivity is much lower than with other technologies.

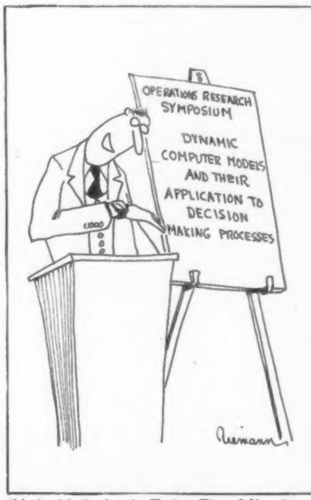
After the late 1980s, and up until the end of the century, there are three additional technologies to consider. The first is a silicon technology using an ECL process cooled to possibly 70 degrees to 77 degrees Kelvin. Another possibility is gallium arsenide, clearly four times faster than silicon and, with an imaginative breakthrough, maybe eight to 10 times faster. A third possibility lies in Josephson junctions, with switching speeds of 10 picosec and less, and a power dissipation measured in microwatts.

While all three of these technologies would have to be operated at some cooling temperature, Josephson junctions have the most difficult cooling problems, since they must operate at superconductive temperatures (4 degrees Kelvin). Moreover, these junctions exhibit external drive loading and sensitivity problems. Because a Josephson junction does not require elaborate heat sinks, however, a denser chip can be packaged, reducing both computer size and internal chip delays.

'Developing new LSI technologies is fine, but they must be enhanced by further breakthroughs in packaging, cooling, power and testing to be successfully implemented.'

Developing new LSI technologies is fine, but they must be enchanced by further breakthroughs in packaging, cooling, power and testing to be successfully implemented. As systems begin to approach their ultimate performance limits, tomorrow's computer designer will have to pay closer attention to all areas contributing to system design in order to stay in the race.

Whatever the future holds for the computer world, some hard economic decisions will have to be made along with the technical ones. The marketplace will not support any technology — no matter how unique and wonderful — if it is not based on a sound economic foundation.



'Heh, Heh, Let's Take Five Minutes to Simulate a Cup of Coffee.'

Staggering under the burden of heavy software maintenance costs, DP managers of the '70s will find relief in the '80s by exploiting their only realistic alternative:

Commercial Software

By Werner L. Frank

Software will be the focus of the data processing scene in the '80s, and commercial software — that is, off-the-shelf packages — may be the only realistic alternative for users if they are to keep up with their needs and match hardware's economic benefits.

The '70s saw a continual drop in the unit price of hardware and a corresponding rise in its cost-effectiveness. During that decade, more and more hardware was acquired for additional applications and with deeper penetration into organizational entities.

This process continues today, and users are struggling with the disparity in the cost of the labor-intensive software effort with respect to hardware.

The full impact of software in the 1980s can be predicted only after examining trends and expectations in the economy as a whole. Considering aspects of the business environment as well as certain organizational factors clarifies what will be the fallout on DP in general and on software in particular.

Given the continued inflation in the business world, labor will become even more expensive. This will, at best, prevent the current modest software productivity gains from having any net effect on the performance of application implementors.

As competition among companies increases, profit margins will narrow. Survival will depend upon finding ways to reduce cost or to allocate resources better. Planning and monitoring, which *ipso facto* is a computer job, will be of essential importance.

Werner L. Frank is executive vice-president of Informatics, Inc., Woodland Hills, Calif.

The heightened tempo of the accelerating industrial world requires fast and correct responses to the demands of all who are served. Information needs are broadening, and reporting and recordkeeping requirements are increasing, especially with the demands made by state and federal governments. Coping with such information needs can be met only by additional use of the computer.

The labor force itself is becoming increasingly committed to a service role rather than being production/manufacturing-oriented. Not only does this dictate greater people intensiveness, but also greater dependency on the computer for support systems.

Finally, organizations are finding themselves in one of two positions at the beginning of the 1980s:

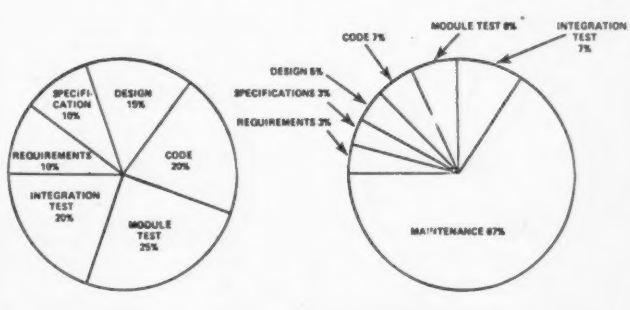
- The veteran DP user has practically exhausted the exploitation of his old application software, which may still smart of 1401 and 360 vintage elements, and is ready to replace the patch-up payroll and general ledger with new software.
- The new DP user, entering the fray with low-cost hardware, is confronted with wide-ranging software offerings.

In both cases the make-or-buy decision looms in the presence of the new economics relating software to less expensive and wider used hardware. The business world and government have little alternative but to exploit the cost-effectiveness of commercial software.

Squeeze Play

Commercial software will receive a boost from yet another direction. The business organization is now maturing in a DP sense, which will make the '60s and '70s look like we were merely dabbling with computers. This change will come about simultaneously from pressure at the top as well as the bottom.

LIFE CYCLE SOFTWARE COST DISTRIBUTION



FROM "PERSPECTIVES ON SOFTWARE ENGINEERING," M. V. ZELKOWITZ, ACM COMPUTING SURVEYS, JUNE 1978

Figure 1

The '80s will see managers experienced in DP promoted to executive positions. This change at the top will influence the impact and role of computers in the organization in the following ways:

- Computing will be placed on a cost-justifying basis.
- DP will be organized by applying techniques of "management by objectives."
- Rationalization of computer usage will be required.

This new breed of executives will be able to ask the right questions and will not be baffled by DP jargon. Data processing will be placed in an atmosphere in which alternatives must continually be studied and justified.

'Management by Objectives'

The techniques of "management by objectives" can now be introduced into the DP organization because management knows what to ask for and what to measure. For example, it will be commonplace for the DP manager to have goals and objectives which measure such criteria and performance as:

Financial

- Budget components as percent of total.

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- Year-to-year total expenditure.
- Total expenditure as percent of sales.
- Cost per unit of output.

Operational
- Percent computer availability.
- Percent nonproductive computer operation.
- Units of output per computer resources.

User Satisfaction
- Percent late reports.
- Budget adherence.
- On-schedule development.

A key notion affecting software decision-making which will not go unnoticed will be the opportunity benefits to be derived from commercial software vs. custom-developed solutions.

The executive who is sophisticated in the DP arena will know that customization has a price. The general-purpose product offering typically satisfies the highest common functional needs of most organizations. Requirements perceived by a user beyond a product's capability will typically be suspect — not because such needs are unnecessary, but rather because such add-ons could well end up being the most costly and/or discretionary elements.

Perhaps what is operating here is the famous 80-20 rule: The last 20% of what a user may require in a system will cause 80% of his cost or schedule overruns.

I believe that conventional software is a clear 80% of the way to any one user's needs in a specific application area. A DP-knowledgeable executive will also understand this fundamental point.

Savvier Population

The second pressure on the business firm of the '80s will come from the entry-level cadre. Almost all current graduates of colleges, and even some high schools, have had an introduction to computers.

Most citizens will shortly have such contact via the newer electronic toys, calculators and computer offerings in retail outlets such as Sears and Montgomery Ward.

This educational process will make the lowest level of personnel aware, receptive and even demanding of electronic assistance in performing their jobs. This will become an invitation for vast commercialization of new software offerings at the microprocessor and workstation level.

The Maintenance Problem

Another underlying factor which is now better understood with respect to the economics of software is maintenance. And the DP manager and his executive boss will surely seek ways to melt this treacherous iceberg.

Two impacts on DP cost result from the maintenance problem. The first is shown in Figure 1, reflecting the life cycle cost distribution between software development and software maintenance. The left pie chart has classically been the focus of cost analysis.

However, the more significant costs are the buried ones, reflected as maintenance and shown in the chart on the right. It is well conceded that the operational software support costs for an application can be two to three times the cost of the original development.

The second aspect of maintenance is the continual need to commit personnel to its support. As applications increase in number, a corresponding increase in the commitment of people is necessary. In most DP operations, 60% of the programming activity is so committed.

These observations suggest an obvious target for improving productivity. Consider for example, the distribution of staff in a DP user organization as shown in Figure 2. It is assumed that a shift from developing software in-house to doubling the purchase of commercial software can move 50% of the maintenance load to a third party.

As a consequence, two other personnel changes are possible. The development effort can be cut, say by 25%, and the management group reduced by 15%. The proposed staffing under this hypothesis would therefore be 80% of the current operation.

Since average salary costs for the personnel removed from the staff are substantially higher than those remaining, the actual impact on personnel costs will be higher than the 20% cut, say 25%.

The consequences of the above shift in user DP expenditures would have the budget impact illustrated in Figure

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3. Doubling the purchased software component and reducing staff expenditure by 25% leads to an overall annual savings up to 10% or frees up existing personnel to tackle other application development backlogs. This potential benefit will not go unnoticed by the astute manager of the '80s and will lead to further support of commercial software.

What Is It?

So what is commercial software? It is all software sold as a product or service. This encompasses the conventional software product, an application service offered on a time-sharing system or by a data services organization and the turnkey system.

Commercial software is somewhat broader than the meaning connoted by the software product alone. It reflects the totality of what can be purchased for solving a problem — and that which can be leveraged because more than one user is served.

The varied offerings for exploitation with commercial software in the '80s will emphasize high-payoff common need interests in the following major areas:

- Accounting and financial systems.
- Order entry and inventory control systems.
- Regulatory and compliance reporting systems.
- Administrative and personnel systems.
- Word processing and related office applications.
- Development tools and support systems.

The first five categories are applications-oriented. They will be increasingly marketed on an industry basis, with emphasis on hardware and software offerings.

The last item includes systems-oriented software to facilitate the implementation of applications by both professional programmers as well as end users. Expanded use of the teleprocessing monitor and the data base system will occur.

Alongside these two keystones, a major new building block for software builders — the data dictionary — will make its appearance and become an important new market.

Parallel Effort

In a parallel effort, nonprocedural language approaches will once more make forays into programming environments. In addition to RPG and the Informatics, Inc.'s Mark IV system, a new appreciation of these techniques will cause query languages to proliferate as general-purpose front ends to data base management systems.

The heavy emphasis on transaction processing systems operating in screen-dependent, interactive environments will lead to new implementations (IBM is calling them "enabling" systems).

Programmers at first, and users ultimately, will be provided with automatic screen generators and dialogue builders such as those already offered by Informatics' Trans IV or Decision Strategy Corp.'s Taps.

The ultimate offerings that will become prevalent in the mid-1980s will fulfill the dream of the "user's workbench." Inexpensive microprocessor-based workstations will provide the tools and techniques necessary to design and program applications.

Room to Maneuver

What, then, will be the marketing environment of the '80s in which commercial software will find itself?

First of all, the economics for an expanding market are present. Users can make long-term commitments to a software investment and enjoy the resulting benefits.

For example, the life span of computers compatible with the IBM 370 line seems clearly to cover the next decade. Without even the announcement of the anticipated H series by IBM, it is already possible to obtain hardware compatible with an IBM 370/158 and have capacity which permits a compounded increase of the work load at the rate of 25% per annum for the next 10 years. Indeed, the capability can be obtained at a price/-performance advantage better than the 158 computer by a factor of 4 to 5.

In this favorable environment, the user can make an investment in currently available software and continue to exploit it for at least a decade.

Such users have a lot of room to maneuver and make gains. Today, only 3% of the existing and operating software base (over $200 billion) is made up of commercial software products. Users budget less than 2% for outside software product purchases. The conditions for the software boom of the

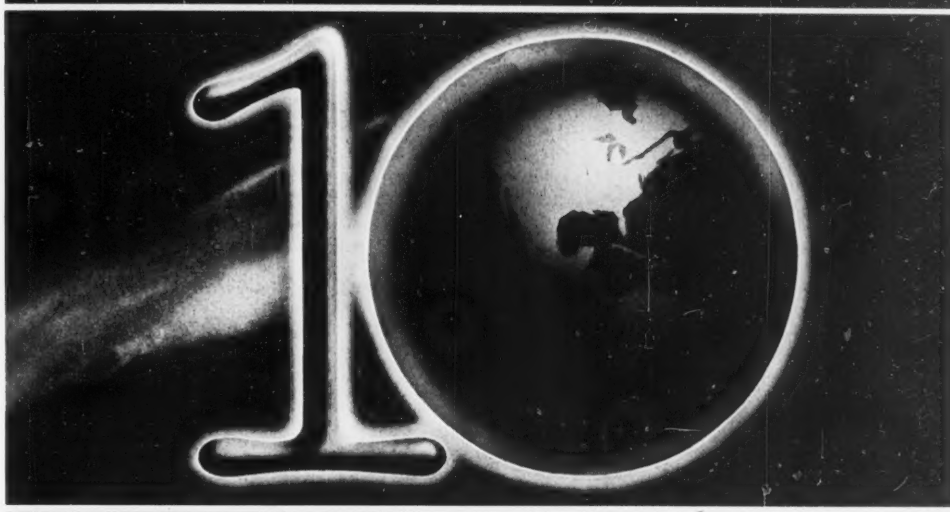
(Continued on Page 22)

1980 DELTAK International DP Training Conference | **April 23/24/25** | **Hyatt Regency Chicago**

"Technologies of immense social and industrial potential will transform social and economic patterns in the coming decade."
James Martin

"The corporations which will excel in the 1980s will be those that manage information as a major resource."
John Diebold

1980s: The Information Decade



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Information Technology in the Eighties

We are witnessing an unparalleled change in communications and information processing. Computing equipment and telecommunications costs have plummeted for everything from micro to maxi computers, from "dumb" terminals to "intelligent" terminals. At the same time, software systems are more sophisticated and productive. The result? A proliferation of distributed intelligence that can be tailored to an organization's needs.

Only by implementing such systems can organizations adapt themselves to meet the needs of the 80s. The proper use of information systems technology will be essential for attaining high productivity and for meeting the many other challenges the 80s will bring.

A Conference for the Eighties

Help prepare your organization for the 1980s by attending DELTAK's 1980 International Data Processing Training Conference. This conference is designed to provide organizations with the expertise to put information systems technology to work.

DELTAK's conference will have something for everyone who must deal with information systems. Top-level executives will receive a timely analysis of business and technological trends. Instructors, training coordinators, and training managers will hear presentations on the latest products and techniques in Human Resources Development. Data processing managers and technical staff will learn about the skills needed to master the proliferating technology of the coming decade.

Main Sessions Feature Diebold and Martin

Main session speakers will present topics of broad technical and managerial concern to the entire conference group. This year's conference will feature James Martin and John Diebold, internationally recognized authorities on the social and organizational implications of technological change. Mr. Martin will discuss rapidly evolving telecommunications and computing technologies. He will focus on the social and economic changes caused by these technologies and their effect on business and industry. Mr. Diebold will discuss strategic issues surrounding Information Resource Management, an approach designed to help organizations manage the information explosion of the 1980s.

Kevin O'Sullivan, executive director of the American Society for Training and Development, will give his multimedia presentation "The Great American Teaching Machine," an entertaining analysis of television's effect on the nation's viewing audience and its consequences for trainers everywhere. Other main sessions will feature selected DELTAK executives reporting on DELTAK's newest products and services in the data processing and management development disciplines.

Concurrent Sessions Focus on Specific Needs and Interests

More than a score of concurrent sessions will be presented, each one zeroing in on a timely topic for executives, training professionals, or data processing specialists. Frances Berger, Rob Ware, John Toellner, William Oncken, and Peter Pipe are just a few of the many outstanding concurrent session speakers. Among the sessions offered will be presentations on Computer-Assisted Instruction, Personnel Trends in Data Processing, the Dynamics of Management Training, and Planning for a Conversion.

Registration

The fee of $175 will cover all sessions for the two days, plus receptions, breakfasts, and lunches. To register, call or write to Sharon Trube, DELTAK, inc., 1220 Kensington Road, Oak Brook, IL. 60521, (312) 920-0700.

DELTAK: Ten Years of Achievement

This conference marks the beginning of DELTAK's second decade. During the first ten years, more than 3,000 organizations worldwide increased personnel productivity with DELTAK's multimedia training courses, a record that uniquely qualifies DELTAK to meet the challenges of the 1980s. DELTAK — the productivity company, helping you to prepare for tomorrow.

DELTAK
The Productivity Company

SOFTWARE PRODUCT IMPACT ON USER ORGANIZATION

REDISTRIBUTION OF STAFF

		NOW*		PROPOSED
MANAGEMENT		19		16
PROGRAMMER/ANALYST				
DEVELOPMENT	16		12	
MAINTENANCE	24		12	
		40		24
OPERATIONS		25		25
DATA ENTRY		15		15
TOTAL		100		80

*DATA DUE TO IDC

Figure 2

IMPACT ON USER EXPENDITURE
SOFTWARE PRODUCT PURCHASE SHIFT

	MODEL I*		MODEL II	
	$M	%	$M	%
PURCHASED SOFTWARE	1,315	3.2	2,630	7.0
STAFF	18,620	45.4	13,965	37.1
TOTAL EXPENDITURE	$41,025	100.0	$37,685	100.0

*DATA DUE TO IDC for 1978

Figure 3

(Continued from Page 20)
'80s are ripe.

The following additional factors will affect commercial software:

1. *Wide choice.* Software products will be available in four price categories, with accompanying limitations reflected in those prices. Take, for example, a general ledger program. One can acquire such a system for as low as $99.95 for the Radio Shack TRS-80 microcomputer, for $2,500 on a small business system, for $15,000 on a large minicomputer or $30,000 for operation on a mainframe. The user must know what he ultimately needs and into which category he falls. He must then be prepared to spend accordingly.

2. *Price independence.* The fact that hardware cost-effectiveness leads to decreasing prices does not necessarily explain how software should behave. It is misleading to view the situation as one in which software costs are *increasing* relative to hardware. The truth is that the unit price of hardware is becoming less expensive and software is standing still, or possibly increasing, but in an inflationary economy.

2. *Increased cost effectiveness.* Despite impressions to the contrary, software as well as hardware will be able to boast of substantial increases in cost effectiveness. A number of software vendors have now been in business for over a decade; they can make comparisons of product performance over a series of releases and enhancements.

In one such study, Informatics' Mark IV system showed an increase in performance by a factor of 10 or more. Given the current price of Mark IV and considering inflation, the cost-effectiveness improvement is more than 12 times compared with the 1968 offering. Such benefits in software will multiply in the next decade.

4. *More appreciation.* The leveraging aspect of software over hardware will be better appreciated. Two examples can be cited. The user wishes to introduce on-line programming techniques to increase productivity. He acquires the necessary software packages (say Applied Data Research, Inc.'s Roscoe) for a monthly cost of $400 and the necessary hardware, including 15 terminals, for a monthly cost of $3,800. This software looks like a bargain!

A second case is the use of a product (like Informatics' Shrink) that automatically compresses data files on storage devices to as little as one-quarter their normal size. For a given expenditure of $30,000, many users are achieving hardware disk storage savings of more than $50,000 per annum. Who says software is more expensive than hardware?

5. *Increased maintenance cost.* Software maintenance charges will increase substantially from the current annual 8% to 10% of product value to 15%. The following argument is offered in defense of this increase.

As noted earlier, software maintenance is typically two to three times the cost of the initial development of an application. If a user can economically justify paying a fraction of the cost of developing a particular software product in the first place, then it would appear that this same user should expect to share proportionally in the subsequent upkeep and maintenance of that product. Assuming that the software life cycle is as long as 10 years requires an annual maintenance charge of 15% of initial product value if the vendor strives to recoup his costs.

6. *Hard-Wiring.* Hard-wired software will be introduced in the early '80s. Texas Instruments, Inc. will probably be one of the early and strong pioneers of this trend, much as it was with its programmable small calculators. This form of delivering software has the associated benefit of providing automatic protection from unauthorized reproduction and use.

7. *Protection.* With the increasing importance of software, its potential value and widespread use, vendors' problems of protecting proprietary interests will increase. Accordingly, new techniques will emerge to control software usage. This protection will be achieved by hardware-imposed devices as well as by software processes which permit operation as a function of the physical CPU, the calendar date of numbers of transactions. Perhaps there will be created an American Society of Computer Analysts and Programmers operating in the world of software just as the American Society of Composers, Authors and Publishers monitors and protects the interests of artists and authors for records and films.

8. *IBM.* IBM will become a contender and a threat to the commercial software vendors of the '80s. It is, of course, already a substantial producer of commercial software, renting software for a value of over $1 billion a year on the international scene, or close to 50% of the total commercial software market serving IBM users.

If IBM continues to emphasize and grow the software business component, two effects will result:

- The market will be blessed and expand even more.
- Software umbrellas and other problems faced by the compatible peripheral manufacturers will emerge for the independent software vendor.

For the benefit of the user, and to assure competitiveness, at least the following will be demanded of IBM:

- It will have to release detailed hardware and software specifications sufficiently early to allow for response to impending change by independent vendors.
- It will have to sell, as well as lease, its software.

9. *New entries.* The Japanese will surely enter the hardware and software markets of the West. At present, there is complacency about Japanese software, especially in the applications area.

Nevertheless, Japan is possibly more automated than the U.S. A Japanese impact on software in the '80s can be expected.

10. *Consolidations.* Business consolidations in the computer industry will continue, with software becoming a more dominant factor.

Accordingly, software companies will be acquiring hardware entities in their pursuit of providing total solutions for users.

Commercial software in the '80s will become an increasing portion of every DP budget. Prospects speak well for the suppliers headed by IBM, followed by independents such as Informatics, Applied Data Research, Cullinane Corp. and Management Science America.

And at the heels of these suppliers are the new breed of software producers, including such names as Instant Software, Rainbow Computing, Darrell's Appleware and TRS-80 Software Exchange. And trailing far behind, but possibly advancing, are the Japanese.

The Next 20 Years in DP

By Charles P. Lecht

Computer and communications systems technology, proliferating across an apparently infinite spectrum of applications at bewildering speed, will attain yet greater ubiquity in the world of the 1980s.

In the 1950s, the use of computer and communications systems was principally restricted to university labs, large corporations and, of course, governments, all of which were in a position to absorb the then considerable costs that characterized activity on the frontiers of our technological sophistication.

By the 1960s, a wider ranging commercial community had found its way to this technology — and vice versa — as familiarity grew and the price of pioneering softened. Smaller enterprises could participate in this evolutionary process.

Finally, in the '70s, individualized use became practical, if not exactly widespread, and distribution of systems, most with communicating capabilities, seemed to be happening everywhere at once.

Artificial Intelligence

In the 1980s, computer and communications technology will mature to the point that true artificial intelligence becomes a nearly standard feature of the applications of that period. And with this phenomenon will come an immensely increased respect for the role of artificial intelligence in our lives, especially as it compensates for occasional lapses in our ability to manifest natural intelligence on demand.

It is indeed hard to imagine human beings ever evolving to achieve alone the degree of power already achievable through today's people-machine symbiotic systems, and the gap between the two seems to be ever widening.

Whether artificial intelligence be used to enrich our voluntary and involuntary sense and response scenarios or our abstract powers of reason, it is clear to me that people-machine duos, created by people, will emerge to bring us people far superior to those we have thus far encountered. Considerations of added-value alone would bring us to this conclusion.

And because of the speed with which we will be able to provide added value to the individual, in terms of his capacity to *do* things — e.g., see better, reason better, remember more and so forth — we will become convinced that further meaningful extension

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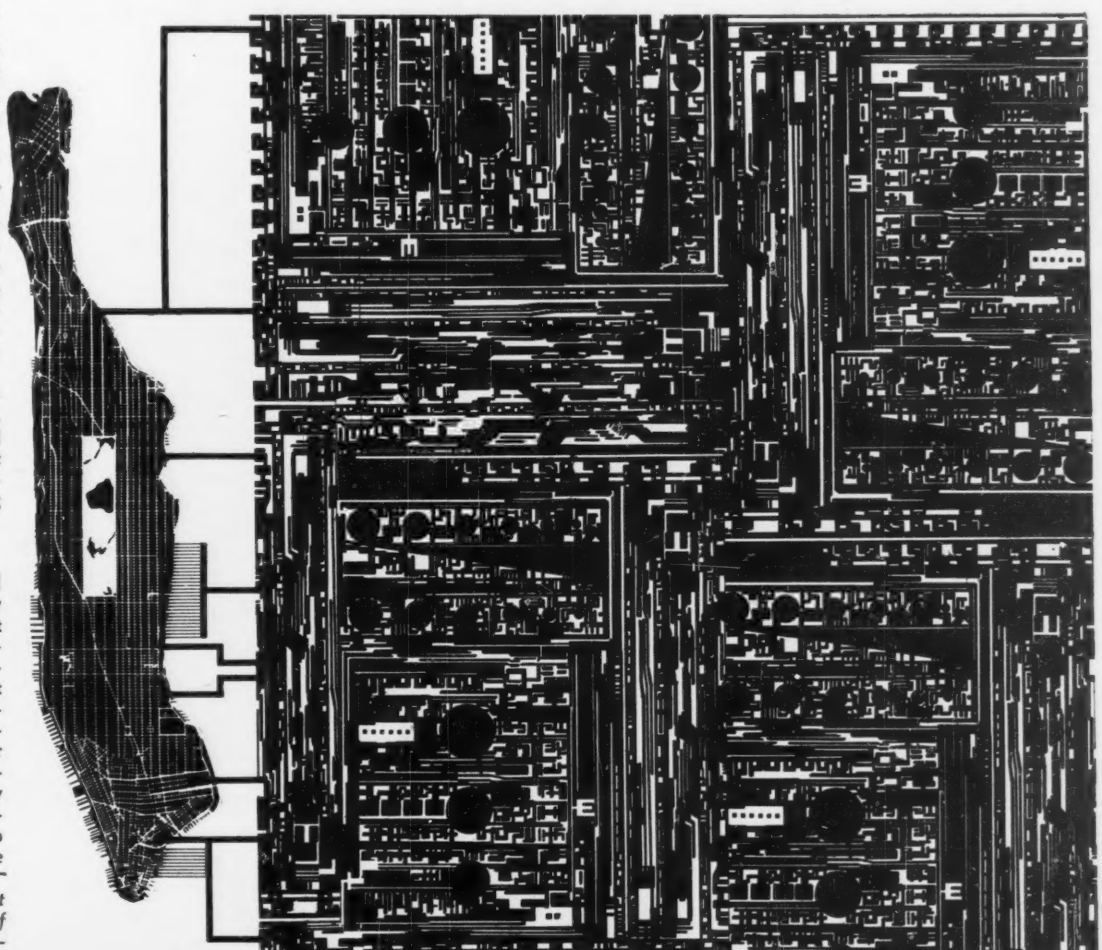

Charles P. Lecht is president and chairman of the board of Advanced Computer Techniques Corp. in New York.

(Continued from Page 23)
of all our faculties though classic Darwinian evolution is clearly not achievable in any reasonable time frame, if at all.

With ever-increasing technological power available to improve all aspects of our endeavor, we will thus relegate to mythology the potential supremacy of people acting *alone.*

It has been evident to me that, to this day, a disproportionate number of our problems in employing machine technology have at their origin the idealistic worship and resultant fear of machines. It would, therefore, seem reasonable that if we could overcome this syndrome, our future ability to apply technology to the extension of our natural capabilities would be greatly facilitated. This would result in a more harmonious and less competitive people-machine involvement, less trauma in the automation process and increased economy.

Technological Renaissance

We are at the dawning of a technological renaissance, a time of growth, progress and enlightenment caused by beneficial waves of change in our computer and communications industries. In 1980, Earth people will walk in a spring-like shower of beneficial innovation as very large-scale integration (VLSI) results mature in logic and memory.

Intelligence and memory add-ons may become available to any person or institution. This phenomenon could constitute the multiplier we need to achieve a true breakthrough in the reduction of ignorance. Some industry analysts say that VLSI chip technology will affect the business environments of the 1980s and 1990s no less than the discovery and ever-widening distribution of crude oil can be credited with having given rise to a revolution in industry at the turn of the century. Perfection of a revolutionary new means of creating, packaging and de-

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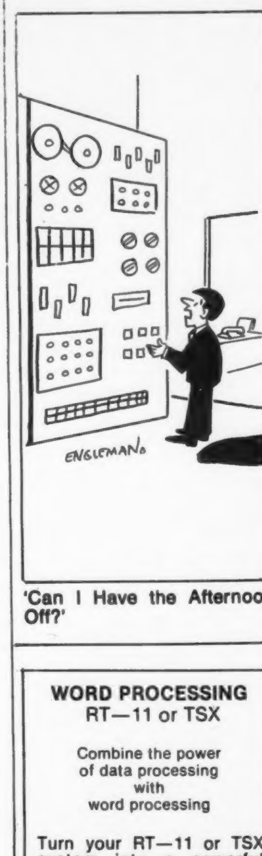

'Can I Have the Afternoon Off?'

"Here are four reasons why we switched to NCR," says Dale A. Dooley of the Iowa Transfer System.

Dale A. Dooley (left) is executive director of Iowa Transfer System, Inc., in Des Moines. Jim Schulte is NCR district manager.

DOOLEY:
The Iowa Transfer System is the first electronic funds transfer system to operate statewide. Over 85 percent of the commercial banks in Iowa are supporting members. We recently installed an NCR 8450 as the central element — the switch — in our network.

NCR's SCHULTE:
It's the element that makes the remote connections, so that every terminal has access to every bank on the network. All across the state of Iowa.

DOOLEY:
Our first reason for going to NCR is monetary. With NCR, our costs are substantially lower than under our previous arrangement.

NCR's SCHULTE:
And at least a bit lower than the other alternatives you explored.

DOOLEY:
Then there is the support we received from NCR and from you, Jim. And NCR's known commitment to EFT.

NCR's SCHULTE:
NCR representatives are specialized. All the people in my group work exclusively with financial institutions. So we are in tune with current financial trends. Other NCR representatives have parallel specialties so they can be more responsive to the problems peculiar to their industries. It's a concept that is working well for us.

DOOLEY:
The third reason is software. Only NCR could provide the switch software we needed when we had to have it.

NCR's SCHULTE:
Not only did we meet the deadline, but the transition to our system was very smooth.

DOOLEY:
Finally, our decision was influenced by the dependable performance of the other NCR systems within the network. And we have had the same experience with this system. Our uptime level has been very high — a critical consideration when you're talking about a network switch.

In the NCR office nearest you, there is an account manager like Jim Schulte who specializes in your industry and knows NCR systems. Learn how an NCR system can help you. Phone him at the local office. Or write to EDP Systems. NCR Corporation, Box 606, Dayton, Ohio 45401.

NCR
Complete Computer Systems

(Continued from Page 24)

livering power, heretofore unavailable, is common to both.

However, it is my belief that the VLSI idea represents a more potent force in our future than crude oil has ever been or will ever be. The kind of power that could be obtained from oil multiplied only our mechanical abilities; VLSI power embraces the intellectual faculties as well.

Call it artificial, a mere simulation, a mime or whatever, intelligence and memory which can now be delivered through VLSI packaging could elevate each and every one of us to live in a world of greatly increased logic and fact recall. This, in turn, should result in increases in human productivity and less wastage.

Management of our natural resources, discovery of new ones and replacement of diminishing supplies through synthetic or natural means will be immeasurably simpler in a world that is more aware. Of great consequence will be a diminishing need for the kinds of power obtainable through destruction of natural resources — a diminishing need for food, thus an increase in its supply.

The mind is staggered at the potential of VLSI technology for the individual in the next 20 years, but those collective institutions which people create and in which they carry out their endeavors will be greatly benefited, too. Clusters of VLSI chips will constitute giant repositories of artificial intelligence, information and means of communication to support our businesses, goverment institutions, educational facilities and military requirements.

Cryogenetically entombed (Josephson junction processor-based devices) nerve centers will exist to extend the operational powers of people's centers of productivity, providing economies unobtainable through any other means we may envision. Our ability to comprehend the physical and spiritual forces that affect our futures will be incredibly improved through global communications and improved processing.

Products vs. Services

The past 25 years of computer and communications systems technologies saw competition between the forces of products and services as automation alternatives. That the product force has dominated may be deduced by looking at the revenues expended by users and obtained by corporations in each area.

The 1980s will see a blurring of the distinction between products and services to the

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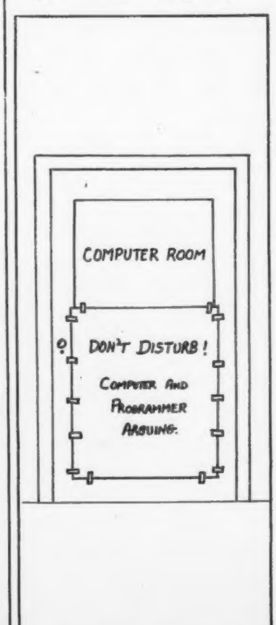

Great Hardware Advances Of The '70s

Appearance of supercomputers, plug-compatible machines, the IBM 4000 series, superminis and a vast array of expanded peripherals marked the '70s as a decade of extraordinary technological development.

By Sidney Fernbach

The '60s gave us IBM 360s and 370s and significant contributions from other manufacturers such as Honeywell, Inc., Univac, Burroughs Corp. and Control Data Corp. In addition, CDC introduced the 6000/7000 series of scientific computers. Minis were what they had always been — small and inexpensive but highly capable, useful tools.

What did the '70s bring us? The decade started off slowly, perhaps because some of the impact of the '60s was still being felt. As the individual years of the decade started passing by, momentum increased and interesting new happenings began to surface. I'd like to consider these in five distinct areas: the supercomputer, plug-compatible CPUs, the IBM 4300 line, the superminis and peripheral equipment in general.

Supercomputers

In the '60s, CDC had captured the title of giant computer builder. It had designed a great deal of parallelism into sequential machines to attain the highest performance achievable during the decade. Many computer "experts" believed the sequential machines were running out of steam and started to dream of even more parallelism.

One concept, orginally designated Solomon (after he of 1,000 wives), proposed putting as many as 1,000 small processors together to work simultaneously on individual large-scale problems. Such a system was contracted for in the '60s and built by Burroughs. Since it was initially intended for the University of Illinois, it was called Illiac IV. After numerous difficulties, it was installed at another site in the early '70s.

Illiac was, at the time, the most powerful computer built, but did have competitors on the drawing boards and in various stages of completion. CDC was working on the Star-100 and Texas Instruments, Inc. on the Advanced Scientific Computer. In contrast to the parallel structure of Illiac IV (which contained 16 simultaneously operating processors), both the CDC and TI machines had a segmented pipeline structure allowing for data in vector-oriented form to be processed in rapid sequence with one instruction.

Each of these computer systems had its problems, which resulted in major delays, degraded performance and, in several cases, poor reliability. These machines, if properly utilized, could achieve performance speeds approximately four times that of the fastest sequential machine of the day.

Programming for these supermachines was somewhat more complex than for the standard machine (if one wanted to get optimal performance). Either the scientist originating the problem, or the programmer or the compiler had to be smart enough to structure the job in vector form. The longer the vector, the better. Scalar work was relatively slow. The performance increased rapidly with the size of the vector.

It had been recognized in the design phase that such machines for their intended applications (nuclear weapons design, meteorology, seismology) required large memories, 16M bytes being considered a good number to shoot for.

Illiac IV suffered on this score, but its users were clever enough to use the specially designed head-per-track disk as "main" memory.

Birth of Cray

Early in the decade, CDC lost the designer of its 6000/7000 series of machines, Seymour Cray. He formed his own company, Cray Research, Inc., and by 1976 had installed the first of the Cray-1 computers.

This machine also was highly vector-oriented. Fortunately for Cray and the user community, it dealt more readily with short vectors and performed at levels beyond the CDC 7600, even with pure scalars. The packaging was superb, as had been previous Cray packaging. By the ending of the decade, more than a dozen of these machines had been delivered. Average performance was in the range of two to eight times that of the best sequential machines, but scalar performance also was approximately twice that of the standard machine. Having set the pace, Cray was ending the '70s with a design for the Cray-2, supposedly another factor of four better than the Cray-1.

In the '60s, CDC had few competitors for its high-performance scientific computers. The '70s were proving to be different. Cray certainly was competitive. TI had entered the fray but found the large computer marketplace less attractive than its other interests and has apparently dropped out. (There may still be a few sparks smoldering there).

Burroughs, having been bitten by the bug in designing the Illiac IV, was now building the Burroughs Scientific Processor (BSP) as a follow-on. It is rumored that one has been sold, but not yet delivered.

The processor is similar in concept to the Illiac IV, but includes some major improvements and innovative ideas. Memory conflicts have been minimized. Memory itself is more than adequate — the back up memory planned is exceedingly large and will be either charge-coupled devices or MOS. Performance measurements have not yet been revealed.

CDC has not been sitting idly by. Recognizing some of the deficiencies of the Star-100, CDC has designed and put into production a new series of machines based on the same design philosophy as the Star 100. This series is called Cyber 200. The first of these, the 203, has been completed and will be installed by 1980.

The 203 actually replaces the Star-100 memory with a higher performance bipolar memory and also adds a high-performance scalar unit to overcome its chief weakness. Several of these have now been sold. The next step in the production of the series is to replace the vector unit of the 203 (which is the same as the vector unit in the Star-100). This will be accomplished sometime in 1980.

Other manufacturers have become interested in high-performance scientific computers and have been involved in design and implementation

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Dr. Sidney Fernbach is an information systems consultant and was formerly the deputy associate director of scientific support at Lawrence Livermore Laboratory, Livermore, Calif.

(Continued from Page 27)
during the latter part of the decade. Denelcor is a prime example. A more amateur group at the Lawrence Livermore Laboratory is designing and building a high-performance system called the S-1.

The '70s also saw the growth of the plug-compatible market for CPUs. Amdahl Corp. started the move by designing and building CPUs that were competitive in performance with IBM's 370/168, the high end of the 370 line. Not only did Amdahl's system outperform the IBM system, but it also used more modern technology and was lower priced. The IBM software packages did indeed operate on this system.

The competition for the plug-compatible large-scale computer market continued through the decade. Each competitor announced newer versions of equipment at lower prices in a leapfrog fashion. Users were delighted.

Amdahl's success was carefully watched and followed by a number of others venturing into the plug-compatible CPU market. Most of them concentrated on the lower end of the 370 spectrum.

Magnuson Systems Corp., Itel Corp., CDC and National Semiconductor Corp. each tried its hand at the marketplace. Some of them eventually went up the scale to the 370/168 level. Hitachi Ltd., in Japan, was actively supplying U.S. vendors with the appropriate hardware.

It should be said at this point that worldwide, the major competition for such large mainframes was coming mainly from Hitachi and Fujitsu Ltd. The latter, of course, has substantial interest in Amdahl and could easily manufacture high-performance computers under the relationship that exists between them.

It was quite unexpected when IBM announced its 30 series of machines — the 3031, 3032 and 3033. These were intended to replace the 370/148, 158 and 168 respectively. Performance was higher and price was lower. Those "in the know" had been expecting two announcements from IBM: a low-end E series and the high-end H series. The 30 series did not seeem to fit!

The plug-compatible responses were there, but users were confused. Should they wait for the real H series or should they upgrade to the 30 series? They actually did both. Instead of buying the 30 series CPUs, they leased them. Likewise, in their wait-and-see mode, they leased the competing machines. This major move to leasing hurt the vendors, including IBM. Some, like Itel, may never compete again. The decade is over and we are still waiting for the H.

Other Large-Scale Computing Activities

One should not slight the other major manufacturers of computers. All made improvements in their equipment line(s). They moved in the direction of larger scale integration, faster and bigger memories and, in general, higher performance. For each IBM move, there was an equalizing reaction to remain competitive. The important result was that the customer benefited most.

In response to the quest for higher performance, many dual processors appeared. It was becoming evident that multiprocessing was around the corner, but there was insufficient experience to argue that major manufacturers were making a significant move in that direction.

Carnegie-Mellon University
(Continued on page 30)

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carried out several experiments, first using an array of minis, later an array of micros. The results are still not convincing enough to cause manufacturers to develop a line of products based on this architectural style. One manufacturer, Siemens A.G. in Germany, has built several multimicroprocessors and is testing the concept.

As another interesting experiment, a number of institutions are using standard or modified array processors as attachments to general-purpose machines to improve performance. There may be some significant outcome.

Seismic processing has involved the use of array processors for fast Fourier transforms and convolution calculations for many years now and the field has been highly successful in improving overall performance. The array processors are tied into the general-purpose computer system as black boxes for doing only the highly specialized arithmetic.

IBM 4300 Line And Superminis

Another reason the user base was upset in the late '70s came about as a result of an IBM announcement. The E series was announced; two machines, the 4331 and the 4341, were unveiled.

Some remarkable aspects of these systems caused concern with the competition as well as the customer. The machine was priced very low. Of course, the software had been unbundled and was priced at a more realistic level than ever before. Together, the hardware and software added to a more customary price.

Another feature of this machine was the first announced use of 64K-bit chips for the memory system. The pricing of the memory, in particular, made the competition sit up and take notice.

Naturally, cuts in the competitors' pricing followed. It was rumored that additional members of the 4000 series were also to appear soon. Most of all, it encouraged even more those who were on the fence waiting for the H series. Could the pricing of the high-performance machine be reduced as drastically? We shall have to wait until the '80s to have that question answered.

The '70s also brought significant changes to the minicomputer. It had always featured a relatively short word length. Now, the 32-bit mini was beginning to make its way into the marketplace.

In the '60s, the IBM 360/370 series had succeeded in standardizing the use of 32-bit words for medium, business and even large computers (in the latter case, 64 bits could readily be used as a double word). Now, the minis could start penetrating the IBM 360 and 370 markets at the low end. Of course, compatibility was lacking as were the well-developed IBM software packages.

Minis or superminis, as they began to be called, were proposed by new entries as well as the well-established manufacturers. Perkin-Elmer Corp., Prime Computer, Inc. and Harris Corp. had products that were coming in as competitors to those of Digital Equipment Corp. and Data General Corp. One of the hottest selling items of the '70s was the VAX 780, the DEC entry into the supermini field.

Word Processing

Another concept that originated in the '70s and was brought into successful operation was word processing. It is not even clear that word processing systems should be called computers.

Wang Laboratories, Inc., IBM and a number of other companies have become very conscious of the fact that office work has to be tied into local or central DP systems. The first step is to automate the office by giving the secretarial staff a word processing system. The '80s will determine where this leads.

Peripheral Equipment

Some signification changes took place in peripheral equipment as well. Memory systems grew in capacity and capability. IBM installed high-performance disk pack systems with built-in intelligence. The plug-compatible manufacturers were not long in outdoing IBM. By the end of the decade, single drives would have almost 1,000M bytes each, access time in the 20s of milliseconds and transfer rates up to 40M bit/sec.

Mass storage systems were also becoming somewhat more popular than they were in the '60s. There certainly was and is a need for these, but users are still wary of them.

IBM led the way with its 3850, which allowed up to approximately 4 trillion bits of information to be stored on magnetic tape in cartridges (50M bytes each) that could be automatically extracted from bins for reading or writing. The tape was approximately 2.7 in. wide and 700 in. long. Access times were in the 10-second range.

The read-write station used a head based on TV tape-recording techniques but with significant modification. The storage system was used in conjunction with staging disks, each of which stored 100M bytes of information, equivalent to two cartridges.

CDC soon followed with its somewhat simpler version, the 38500. It also used wide tape and the mailroom bin-like structures for the storage of smaller cartridges. Total capacity ranged from 125 billion bits to more than a trillion bits. Access times were similar to those for the IBM 3850. It took a few years to shake out all the bugs in these systems, and even then they were not sold in large quantity — perhaps several hundred, certainly less than 1,000 in all.

A competitor who was somewhat more successful in capturing the fancy of the users was Calfornia Computer Products, Inc. with its Automated Tape Library (the product has been taken over by Braegen, Inc.) It permitted the user to store standard 6,250 bit/in. reels of magnetic tape in a slotted structure from which they could be extracted automatically for read or write on standard tape drives. Because standard tape and tape drives were used, the cost of such units was far less than the cost of the IBM 3850 or CDC 38500.

Other technologies were still around but not being pursued by users. For example, Precision Instruments (now Omex) had its laser-written storage device, which was being modified to read and write on square plates rather than on long strips of sandwiched metal. The use of holography for mass storage was still being explored, but had not found its way into the marketplace by 1980.

Ampex Corp. developed a mass storage system based on the use of TV tape techniques. Recording was in redundant digital form. Twenty-two 3,600-ft reels of 2-in.-wide tape could store a trillion bits of information. Several of these were sold and are in active use today.

Toward the end of the decade, the TV industry was producing disks for use in "instant replay" and for the home recording/playback market. These could be converted to low-cost digital data storage devices. A number of proposals to build such systems were made before 1980. These may become important storage media for the digital industry in the near future.

Printing also took a new path in the '70s. Impact printers had been standard for many years. Such devices had inherent limitations in speed. The '70s saw large inroads made by nonimpact printers. Speeds of up to 20,000 line/min became feasible, a factor of 10 greater than the previous standard. Because these printing systems were controlled by minicomputers, greater flexibility in style, paper size and other printing features became possible as well. Honeywell, IBM and Xerox were among the major suppliers of such equipment.

Some very inexpensive nonimpact printers became available early in the decade. Gould, Inc. and Versatec, Inc. set the pace.

The '70s also saw a more widespread use of computer output microfilm (COM) units. Stacks of paper output, common in the '60s, were being replaced by microfiche, short strips of 105mm film containing approximately 200 frames (pages) of information on a single strip. Many COM units were highly flexible, being useful for producing high-resolution 16mm and 35mm film in both black and white and color. Remarkable improvements in quality have been made in the past decade, such that high quality graphic capabilities can be added readily to almost any computer system today.


'I Don't Know How to Tell You This, Beatty . . . You've Been Replaced by a $6 Pocket Calculator.'

DP Operations in the '70s:

A Decade Of Management Maturity

"Technology, though a major factor, is not the major contribution of the 1970s toward the development of data processing. Management is."

By Robert J. Benson

Data processing has come a long way, baby — and for that matter, data processing *was* a baby 10 short years ago. Why, the field really didn't exist 10 years before that; the 1960s was the decade of its beginning, the birth of DP as a major force in business and enterprise. The 1970s saw the field maturing, learning how to cope with technology and developing a concrete understanding of the management tasks necessary for DP operations success.

It would have been hard to imagine the degree of progress possible when viewing the future in 1969. If nothing else, a considerable vocabulary has emerged: distributed systems, distributed processing, structured programming, software engineering, microprocessor, office automation, security/-privacy, DP audio . . . the list goes on. And yet, with the possible exception of micros, the technology in use today is essentially that in sight in 1969.

For it might be thought that technology is the greatest contribution of the 1970s. Thinking back, we recall that the IBM product line in 1969 was still the 360. Data communications was in its infancy, data base management had only begun and the wisdom of the day held that centralization, relying on large central mainframes, was the ticket to success.

Robert J. Benson is assistant vice-chancellor and director of the Center for the Study of Data Processing at Washington University in St. Louis, Mo.

Today it seems that the technological forces are moving in the opposite direction towards distribution and decentralization of the DP function — "power to the people." Future technology advances such as very large-scale integration (VLSI) and low-cost, high-capacity mass storage would seem to be the major influence on the future of DP.

Major Contribution of '70s

Yet closer inspection demonstrates that technology, though a major factor, is not the major contribution of the 1970s towards the development of DP. Rather, *management* is.

Unquestionably, the technological forces at work are astonishing, particularly when viewed from the perspective of the 1960s. Who would have foreseen (or believed) the tremendous price/performance improvements, the number of computers installed, the reduction of entry-level computing costs and the number of terminals in the hands of users. The technology is overwhelming, but what is even more amazing is that the DP organization has improved its ability to manage services in the face of the technology changes.

1. Management abilities to decide what to do have moved from the 1960s blue-sky concept of a single corporate management information system (MIS) to the understanding that long-range DP planning is a corporate planning process covering many application areas and many data bases. For example, the kind of thinking represented by Richard Nolan's stage theory of DP has produced recognition of the long-range and short-range planning cycles involved. I'm told that more than 400 customers have used IBM's Business Systems Planning for long-range systems planning, one of several methodologies available that were developed in the decade. DP management increasingly uses cost-benefit analysis and return-on-investment justifications for systems. Organizations such as the Society for Management Information Systems (SMIS) have increasingly focused on methods for systems planning and have developed a quality literature on the subject. All of this is a demonstration of the maturing of DP management views.

The point here is not that the profession's planning and management abilities are perfect — far from it. Rather, the point is that the DP field now largely recognizes the need for long-range MIS planning and has largely succeeded in putting into place planning/management mechanisms to accomplish such planning. This is a very significant accomplishment in this decade.

2. Our management abilities to decide how to develop DP systems has undergone revolutionary change. The vocabulary has been enriched with terms such as "structure," "software engineering" and "proof of correctness." One may hold strong views on the strength of one approach versus another, but we cannot deny the improvement in programming and systems development methodologies.

At the beginning of the decade, there was almost no help to DP management in this area; now we have a large number of analysis and design techniques to choose from, many of which have been demonstrated to improve the quality and quantity of the systems development efforts. In short, we now seem to understand how to manage development projects.

At the same time, the development of support technology has produced data dictionaries, on-line screen management aids, report generators, interactive testing facilities, source program maintenance systems and test data generators. A host of techniques are now routinely available to the smallest shops. It's a big step from the 1969 environment and the worry about whether to use Cobol.

Better Applications Systems

3. Application systems are better, better by far than the systems being installed in the early 1970s. Some of it is technology; the limits of computing now have much less impact on what can be done. Cycles are cheap and storage is cheaper. Thus, truly effective inquiry facilities, report generators and data base management for shared data are routinely available.

Indeed, the ability to provide really good application systems has created new problems: a backlog of future applications and a sense that future systems are more complex because they truly are integrated into the business. I've even seen it claimed that the national business cycles have been impacted by the improved application systems, chiefly inventory management and materials planning systems. The growth of effective application software packages accentuates the trend to better application systems.

At the same time, the sense of what is

(Continued on Page 32)

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important in audit, control and system security is much better focused. The emergence of the DP auditor and the development of well-understood concepts about applications controls all occurred in the decade. One need only look at materials published by such groups as the Institute of Internal Auditors to realize how substantial the progress has been.

4. DP management has learned how to manage the operation, meaning the hardware/software technical complex used for the delivery of services to users. The decade has produced a wealth of management tools and approaches in a variety of areas: capacity planning, privacy and security of the data center and individual systems, accounting and user charging, tape and disk space management, communications network management, programming standards, work scheduling and quality control. Most have developed considerable structure and content and even software systems to support them.

By now the reader must be asking: So what? If the management progress has been so magnificent, why do we still see signs of corporate disenchantment with DP? Why do directors of DP/-MIS tend to be replaced? If we're so smart, why ain't we rich?

In spite of the foregoing glowing reports, that things aren't totally satisfactory in the DP management world can be seen in two ways: First, most large data centers have a very large backlog of application systems development efforts, perhaps three or more years with current staff levels. Second, most large data centers have experienced very large increases in cost budgets, with even larger ones looming in the future. Given the net reductions in technology costs, this phenomenon is a caution. And if systems development methods are so positive a development, why the large backlogs? It is certainly hard to explain this to senior managers.

Well, of course, we are victims of our own success. Every successful application creates a very dangerous result — a user manager who has learned something about the contribution of the computer to the business enterprise. Thus, we not only have new users, but old ones who are now much more sophisticated and have wonderful ideas about what should come next. At the same time, applications are in fact more complex; we largely have done the simple applications and now are facing ones that demand a much higher level of business understanding.

It is at this point that technology looms again. What has happened, of course, is that the decade of the 1970s also produced the small computer system with advanced software capabilities — the minicomputer and the microprocessor — with costs that seemingly are much lower than those of the traditional forms of computing. And to some, the allure of having low-cost computing available directly in the user department is irresistible. Think of the advantages of having the increasingly sophisticated user do for himself what used to be done for (or to) him by the DP organization!! Worse, technology is providing a host of new application areas such as word processing and the other aspects of office automation that seem to lend themselves so well to distributed and decentralized hardware outside the scope and control of the traditional DP organization.

So the fundamental irony: technology isn't the major contribution of the 1970s (data processing management capabilities are), and yet the emerging technology is threatening to undercut the very management advances of the decade, especially given the increasingly sophisticated user and the application backlogs of most data centers.

Of course, in may ways distributed/-decentralized technology permits a more efficient delivery of services from a traditional DP organization.

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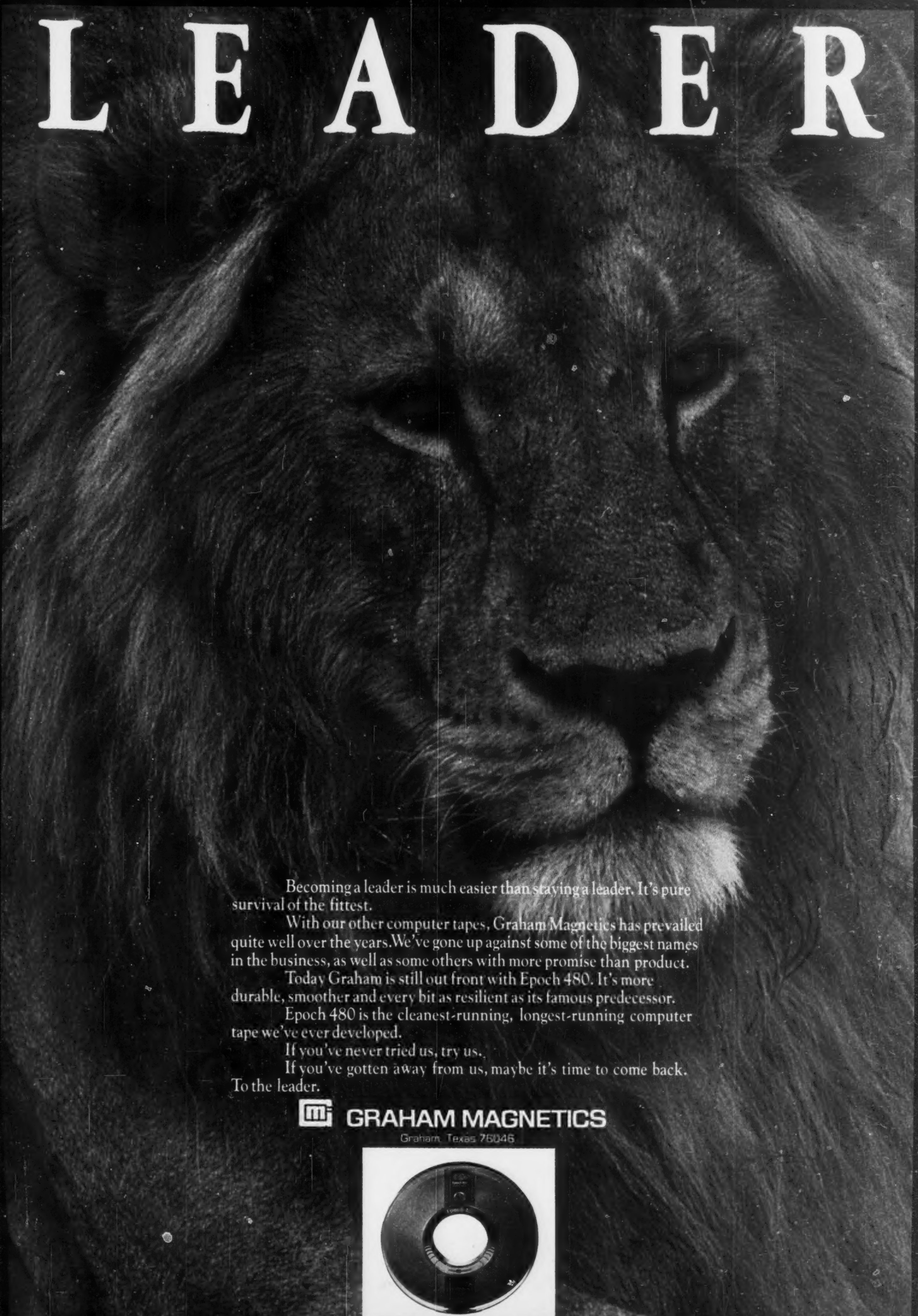
'Eureka!'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(Continued from Page 32)
After all, to a user sitting at a CRT screen, the source of the CPU cycles or the data being processed is not a vital concern; performance and reliability are.

Not an Alternative

The key to continued development and maturing of DP management in an age of distribution/decentralization, in my view, is to regard the technology opportunities as *part of* the overall DP delivery complex (and its management challenges) ***and not as an alternative to it.*** With this framework, we can continue to benefit from the management lessons of the 1970s. Of real hope is that many DP organizations have managed to do just that.

The insight is to regard any technology choice — whether centralized, decentralized or distributed — as a strategic decision. The important point is that a decision to implement a user system is a commitment to continue that system indefinitely, and the use of a specific technology approach to that system is a commitment to continue that technology indefinitely. DP management has understood this from the standpoint of centralized systems — indeed, the very management advances described earlier reflect the management problems of providing services to users over time. In short, the challenge of decentralized/distributed technology is to apply the same management advances that have been developed in a centralized environment — long-range MIS planning, systems development methods, "good" application systems tools and suitable operations management tools.

We don't want to start over again; we particularly don't want to force users to start over again by treating decentralized technology as an alternative to the current DP organization, a real danger given the dismay at application backlogs and increasing central center costs (resulting from growth). Failure to understand this point will take the DP effort back to 1969, with a maturing management decade to come rather than a decade that builds on the one behind. Thus, with word processing and office automation, for example, we have the opportunity to build on the management maturity earned during the 1970s or alternatively to repeat the learning experience.

DP *has* come a long way since the 1960s. If we characterize the 1960s as the initiation decade and the 1970s as the consolidation/maturing decade, hopefully 10 years from now we will look back on the 1980s as the decade of integration, with the increasing penetration of DP into all aspects of the enterprise. If so, it will largely be because of the management maturity gained during the 1970s.

'Hey, Glen. Haven't Seen You Since the Cryogenics Project Started.'

When IBM Unbundled...

IBM first unbundled its software on Jan. 1, 1970, unleashing the competitive forces that spurred a decade of software advances. The full impact is only now being felt as the unprofitable developments of the '70s become the new markets of the '80s.

By Martin A. Goetz

The single most significant development of the 1970s occurred, ironically, on Jan. 1, 1970 — the day that IBM unbundled its software. That announcement marked the start of software competition, software innovation and software pricing.

Now, nearly 10 years later, there is an active, competitive software products industry that grosses annual revenues in the $2 billion range and is represented by more than 1,000 companies marketing over 3,000 programs. Although long overdue, software unbundling provided the impetus and was the catalyst for much of the significant software developments of the 1970s.

This article outlines some of those significant software developments for commercial users of the IBM 360 and 370 series or their equivalent. The developments that are covered range from the more notable new software packages to a host of important trends, directions and events that were all a part of the '70s.

Some software areas are also included because there is an obvious absence of any real advances. Perhaps these areas will become the focal point for significant development in the 1980s.

Application Packages

Prior to 1970, a user rarely could purchase an application program meeting his requirements. Except for a few insurance, banking and manufacturing packages, application packages became a phenomenon of the 1970s.

While most of these packages required customization, the application package made a major contribution in the 1970s by reducing the amount of programming needed by a user. Such packages, however, are often only starting points for the full implementation of an application.

The application package will continue to be viewed as a skeletal system to be customized by the user until such package vendors provide object code only. True application packages of the 1980s will reflect more paramaterized options, and those packages will accelerate at an even faster rate than those of the 1970s.

System Software

Although system software packages were marketed or were available "free" in the 1960s, they were few in number. In contrast, there were literally thousands of systems software packages sold in the 1970s.

These packages demonstrated their popularity and importance not only by crossing industry lines through their generality, but by also crossing geographical boundaries into the world market. Unlike application packages, system software proved to be true packages — only object code was delivered.

Without the need for program customization, a system software product user depended on his vendor for complete maintenance, enhancements and service. This significant development allowed users to reduce their continuing costs to a relatively small maintenance charge.

Advent of DBMS

One of the most significant system software product developments of the 1970s was the data base management system (DBMS). It was sold in an intensively competitive market with a multitude of claims and promises about its benefits. While there are still many installations today that do not have DBMS packages, or that do not use them properly, DBMS packages are gaining wide acceptance as the core of a new user application.

Although DBMS development was initiated in the 1960s, the 1970s marked significant strides in DBMS technology and methodology for the commercial user. The problem, however, has been that most users have not been prepared for the technological advances. Not only have users experienced difficulty in using these systems effectively, but DBMS packages have been brought into many firms without sound management understanding of how to introduce and control this new software.

The lack of a data base administrator to define the use and control of data, the difficulty in integrating existing computerized and manual systems to accommodate the DBMS application and the high degree of training required have created an endless set of difficulties for the typical DBMS user. The net result has been that the benefits of these new systems have often been outweighed by the problems they created.

Nevertheless, the realization that DBMS packages can significantly lower the cost of both application development and maintenance has been demonstrated to those organizations that used the DBMS effectively. The 1980s will undoubtedly see a full realization of the potential of DBMS packages.

Data Dictionary

The use of DBMS packages brought a realization to DP management that data was an important corporate resource that was shared by many internal users. The DBMS thus became a catalyst for the data dictionary.

Just as the need for DBMS packages was first recognized in the 1960s, the need to control the use of data was first recognized in the early 1970s. At that time, articles and surveys on the use of and need for a data dictionary appeared. In a survey article published in *EDP Analyzer* in 1974, for example, Editor Richard G. Canning described the relatively few data dictionary systems available and the few progressive companies that used them.

By the end of 1979, in addition to stand-alone data dictionaries, almost every DBMS supplier provided a data dictionary as an optional part of their DBMS. While data dictionaries are important for conventional applications, the DBMS applications provided the impetus for data dictionary development.

Use of data dictionaries today are, however, more of a DP goal than a practical reality. Data usage and definitions still are not centralized within a data dictionary at most installations.

There can be little question, however, about the need for a data dictionary in a company. It can significantly reduce maintenance costs; it can be a central control point for data and program security; and it is a necessity to effectively use distributed data bases. Data dictionaries and their effective use will become an essential requirement for every installation in the 1980s.

Data Security

Although data dictionaries provided a degree of security against unauthorized use and misuse of data, they only provided a limited degree of protection. Much more was needed in the 1970s.

The security of data became a critical requirement in the 1970s for two basic reasons: the first was the availability of terminals to almost anyone within a corporation; the second was the increasing volume of corporate data being placed in a computer — and much of it was directly accessible on disks. The result was a significant increase in computer crime.

Data in the 1970s was made more secure by a variety of software packages, disciplines and operating system features. In addition, combinations of hardware and software also provided solutions. Passwords for the use of data and files represented the earliest application of data security.

Data encryption software packages and hardware based on the National Bureau of Standards encryption algorithm, operating system extensions and data security packages were also developed to ensure the protection of data. While effective data security is still only practiced at a small number of installations, the implementation of effective data security systems will be credited as an important development of the 1970s.

The proliferation of low-cost termi-

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Martin A. Goetz is senior vice-president and director of the Software Products Division at Applied Data Research, Inc. in Princeton, N.J.

(Continued from Page 35)

nals and disk storage made it practical to develop cost-effective on-line applications. With the availability of a host of competitive teleprocessing monitors, on-line commercial applications became very commonplace in the 1970s.

Today, on-line applications controlling over 1,000 terminals are practical and easy to program through the use of teleprocessing monitors.

Transaction processing applications, which can be quickly developed, enabled many organizations to implement effective systems that significantly improve the speed and responsiveness of DP requirements within a corporation.

These systems supplied timely corporate data on-demand and eliminated many delays associated with batch processing.

These on-line systems also processed new input immediately and provided instant feedback. This significantly changed how a business processed data and serviced its customers. It is estimated that well over 50% of the IBM commercial user community developed at least one major on-line application using a teleprocessing monitor.

VS Operating Systems

While the teleprocessing monitor provided many facilities for the on-line application, the new VS operating systems were providing other important services for the DP users of the 1970s.

The new VS operating systems permitted a greater number of programs to be executed than was previously possible in a multiprogramming environment. While these systems used a great deal of space and CPU cycles, they simplified the programming of applications and provided a great number of services.

Application programs no longer had constraints on memory size, and system design was simplified. Applications that previously were unfeasible became practical. These new operating systems also improved the portability of programs among computers with different hardware configurations. Finally, they helped make on-line and real-time applications more viable.

The early VS operating systems of the 1970s had only limited success, however. Many users found it degraded total throughput even though more programs could be processed at the same time. The number of errors in these new operating systems and the cost of conversion from one operating system to another created a high cost for users of these systems.

In addition, many system programmers were required to service the systems which became more and more complex — so complex that they increased the need for performance measurement tools.

Performance Measurement

As more and more programs, both on-line and batch, were being executed within a computer system, the need for performance measurement tools continued to grow in the 1970s. While the cost of hardware continued to decline, the overhead and complexity of the new VS operating system and new applications made efficiency and throughput a critical element for the computer operations department.

Performance measurement tools were used as a tuning aid in multitask environments and helped to spot bottlenecks in a system. They became essential tools in large real-time environments and helped to determine and justify improvements in hardware and software configurations.

In fact, the downgrading of equipment became achievable through performance measurement tools.

Thus, the effectiveness of the hardware, applications and operating systems of the 1970s was maximized by the many software monitors and program and system evaluators that were developed.

Programmer Shortage

While computer hardware was becoming less and less expensive, total DP costs continued to increase in the 1970s. Although "canned" application packages, DBMS systems and teleprocessing monitors reduced the cost of application development and maintenance, the need for application and system programmers continued at a high level.

The 1970s saw a great shortage of both application and system programmers, despite predictions in the 1960s and early 1970s that software packages and firmware would reduce the need for programmers.

Similar predictions are now being made for the 1980s, but they are idle

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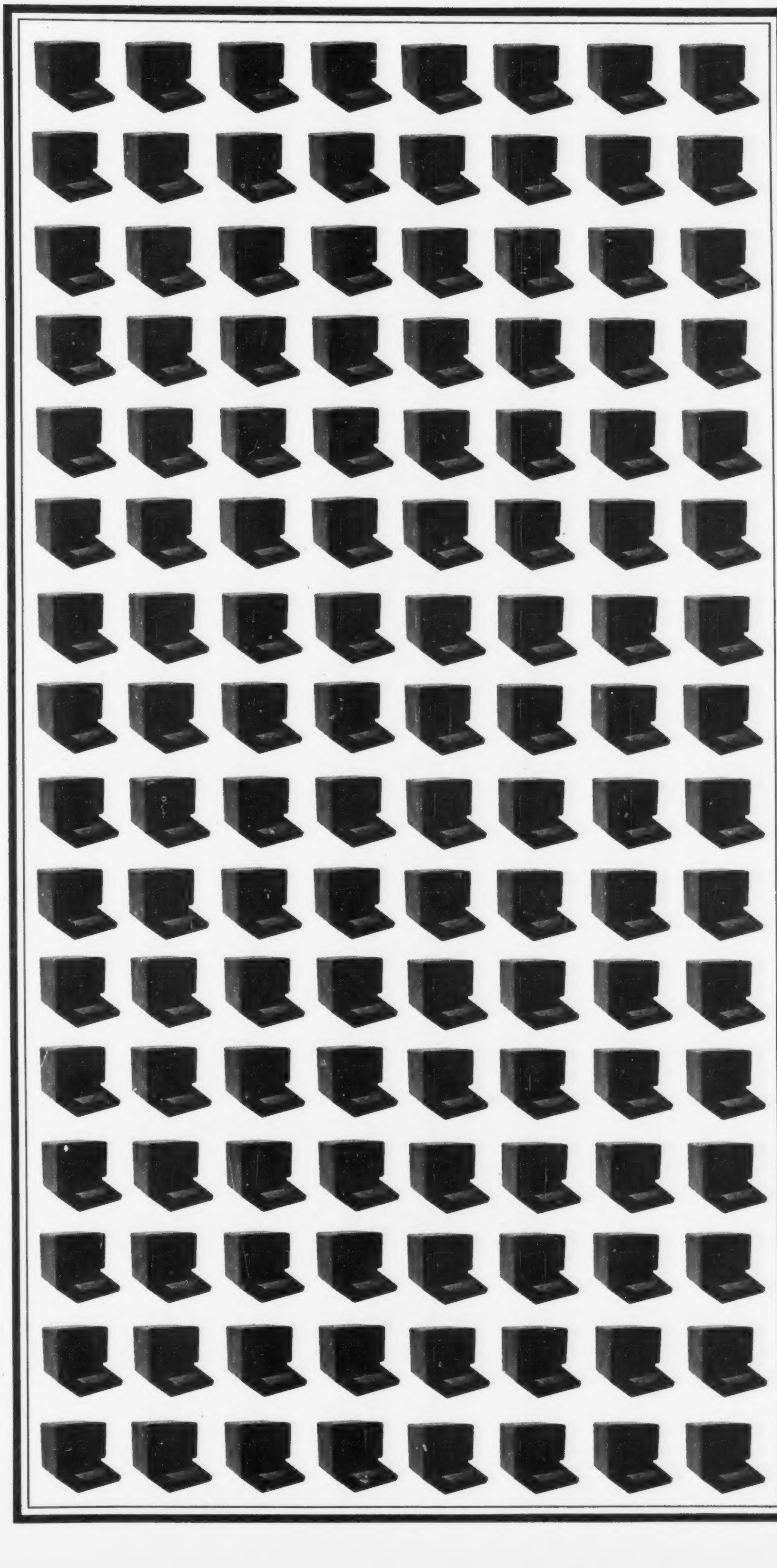

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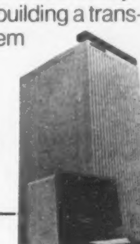

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dreams. Application products will accelerate the automation of a company's processing requirements, but the need for programmers will likewise increase — and at a greater rate than in the 1970s.

Additionally, because of the proliferation of low cost hardware, the number of new computer users will continue to increase at a fast rate. This will also contribute to increasing the programmer shortage. It is also true, however, that new programming and programmer tools have increased the productivity of programmers, thus amplifying their effectiveness and acting as a counterforce to the personnel shortage.

Software Tools

The productivity of programmers, the number of programmers at an installation and the cost of programming is directly tied to the tools at a programmer's disposal. The 1970s saw the introduction of many software tools that had a significant impact on increasing the effectiveness of both application and system programmers.

These tools allowed application and system programmers to develop, maintain and test programs in an on-line or batch environment.

They also allowed system programmers to manage the operation environment more effectively.

In the beginning of the decade, program development and system maintenance tools were slow to gain acceptance in companies. Whether this was the result of lack of funds, lack of awareness or fear of change is uncertain. But in the mid-to-late 1970s, the use of these tools began to increase at a faster rate.

Today, program development and system maintenance tools are recognized as the key to the productivity of programmers and as a major factor in reducing the overall cost of program development and maintenance.

On-Line Programming

With the advent of inexpensive low-speed terminals, on-line programming software packages of the 1970s made a significant contribution to improving the productivity of programmers and increasing their morale. Today, if an on-line programming system were taken away from a group of programmers, there undoubtedly would be mass resignations. Reduce the response time and you will quickly hear about it.

The 1970s saw on-line programming systems become the vehicle for accomplishing a wide variety of programming chores — performed by application and system programmers, operations personnel and end users alike. Thus, the 1970s saw the development of on-line programming systems as a basic productivity tool for a great number of installations.

Source Program Management

Another basic programming system of the 1970s was the source program management system. While DP personnel take a source program management system for granted, it is comparatively "new." It is essentially a product of the 1970s, although it had its roots in first- and second-generation software programs.

Until the early 1970s, most companies had little control over their application source programs, which were usually on cards or in card-image form on disk or tape. There was little management or control in determining who was authorized to change the program and when it could be changed. Competitive challenges, user-suggested improvements and availability of terminals in the mid-1970s enabled source program management systems to grow both in function and capability.

Today, source program management systems are a basic requirement fc· any DP installation and provide the DP manager with perhaps his most important software product. It is the source program management system that safeguards his millions of dollars in valuable programs. It is hard to believe that only 10 years ago, DP management did not worry about those critical corporate assets!

Generative Systems

As the number of programs and programmers continued to increase, the users' total costs also continued to increase. Alternatives to programming were on every DP managers "wish list." And in the 1970s, many alternatives appeared that could eliminate a programming chore or reduce its cost.

Rather than develop a program in a language such as Cobol or PL/I, many companies selectively developed applications with packages that used such nonprocedural languages as Mark IV.

(Continued on Page 83)

Data Communications in the '70s:

A Decade of Birth

By Howard Frank

During the 1960s, the field of modern data communications was conceived. During the 1970s, birth occurred. It was, of course, a multiple birth and as its growing vocabulary would indicate, the offspring are too numerous to be fully chronicled here.

Let's look at those elements of the 1970s which are likely to have the largest impact on the 1980s. Since any fair judgment on our perspicacity must await the end of the next decade, we'll move into the following paragraphs with great confidence.

Today's data communications system is likely to comprise a wide range of devices including terminals (dumb or intelligent), interfaces, modems, multiplexers (static, dynamic), concentrators, front ends, message processors and computers (mini, micro, mono or multi). Typical devices can be placed into categories, such as those shown in Figure 1.

Ten years ago, most of the concepts embodied by these devices existed, but few practical, cost-effective components had been built. Major developments include the emergence of low-cost statistical (dynamic) multiplexing/concentrating devices, the offloading from hosts of communications functions into special-purpose minicomputers and microprocessors and the development of network control and diagnostic systems.

Along with the emergence of network devices were new architectures which allow users to incorporate these devices into a network system with high cost-efficiency.

Packet Switching

Most users are familiar with the classical "centralized" teleprocessing system, which originally consisted of a processor connected by leased or dial-up lines to terminals. During the last 10 years, this structure has evolved to include front-end processors, multiplexers, concentrators, remote satellite processing units, control units and terminals (possibly intelligent) as illustrated in Figure 2 on Page 40.

Such a network, while still generally classified as a centralized system, is in reality a "distributed" system. However, today the word "distributed," when used in the context of networking, generally evokes the term "packet switching."

Packet switching is almost entirely a development of the 1970s. Pioneered by the Advanced Research Projects Agency (Arpa) of the Department of Defense, the Arpanet began life in 1969 on the West Coast as a four-node network. By 1975, it interconnected over 100 computers of diverse manufacturers through a network of more than 50 minicomputer-based packet switches (Figures 3 and 4).

Today, packet-switched networks are providing data communications in the U.S., Canada, France, England and Spain. Moreover, numerous networks are being planned as public or private offerings.

NETWORK DEVICE CATEGORIES

1. **Bandwidth Sharing**
   * **Multiplexers/Lineplexers**
   * **Concentrators**
   * **MSU/PSU**
   * **PBX**
   * **Software Multiplexing (Polling)**
2. **Distribution of Information Processing**
   * **Front-End Processors**
   * **Message Switches**
   * **Concentrators**
   * **Line Controllers**
3. **Switching**
   * **Circuit or Line Switches: Trunk Switch, PBX**
   * **Store-and-Forward Switches: Message, Packet**
4. **Interface**
   * **Modems**
   * **Terminal/Equipment Interfaces (Data Access Arrangements)**
5. **Testing/Diagnostics**
   * **Communications Quality**
   * **Network Control**

Figure 1

To understand why packet switching is superior in many respects to its message-switching (store-and-forward) ancestor, it is useful to see how the constraints which shaped message switching have changed in the last few years.

A communications network can be envisioned as a system of channels and nodes. Nodes are terminals or relay points, and channels are the communications links connecting the nodes.

Control Procedures

Control procedures for communications networks can be divided into two general classes. Message control procedures are those that ensure the proper movement of messages from originator to addressee (between terminal nodes) through the network. Channel control procedures are those that ensure the proper movement of messages over a particular channel, which is only one component of the network.

The availability of high-speed channels, digital logic and advances in adaptive routing techniques have led to new classes of store-and-forward networks with a new message control philosophy. In packet networks, message delivery from originator to addressee occurs in a few seconds instead of hours or days. This quality, among others, makes feasible a superior concept of message control characterized by end-to-end positive acknowledgment, whereby a node receiving a message sends an acknowledgment back to the originator.

Intermediate relay nodes are relieved of elaborate accounting and storage requirements for transmitting messages because the end-to-end or addressee-to-originator acknowledgment philosophy is an encompassing and protective message-control scheme. It minimizes the role of intermediate relay nodes to that of routing and participation in channel control.

The error control scheme on each channel is so powerful that the possibility of an undetected error is once in several years. Channel control and coordination are so sophisticated that there is essentially no lost data.

End-to-end message control philosophy

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Dr. Howard Frank is president of Network Analysis Corp., Great Neck, N.Y.

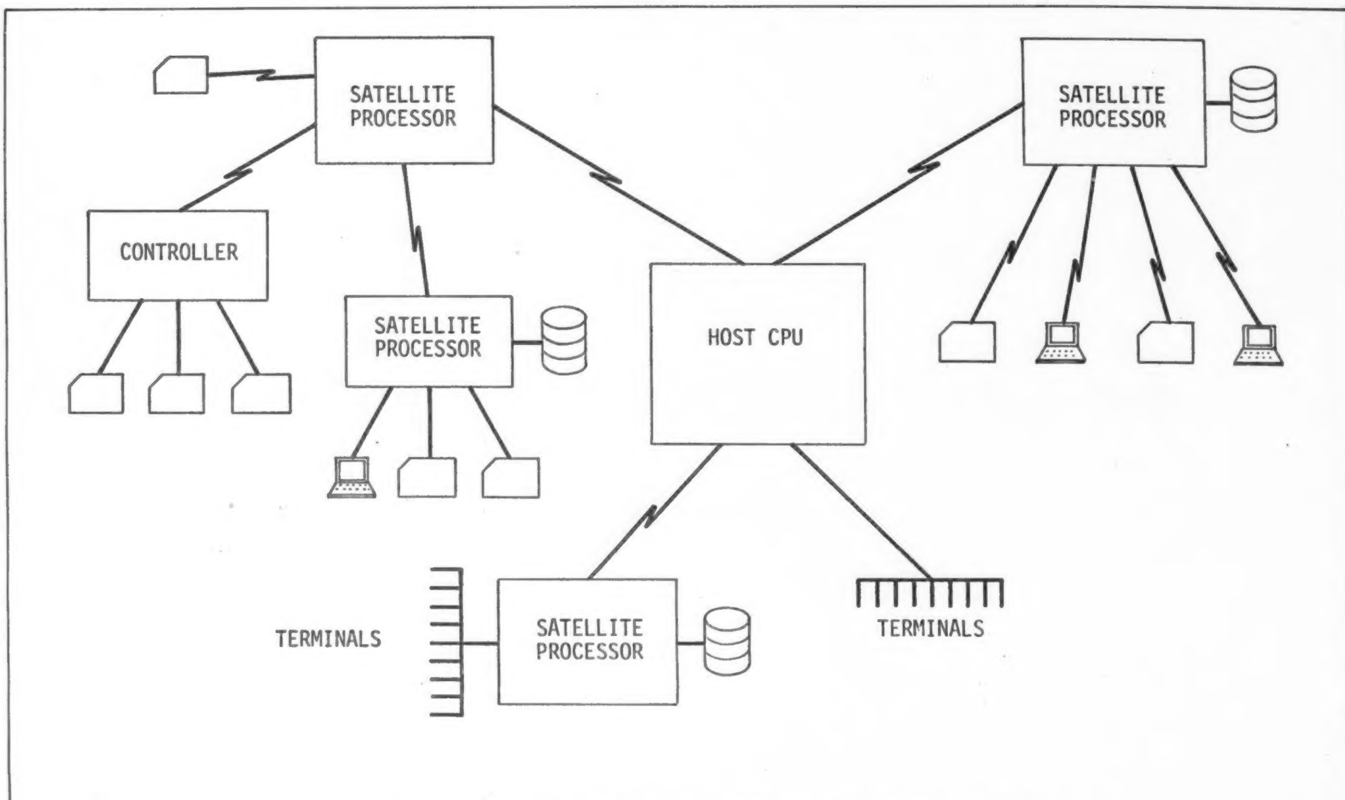

FIGURE 1: THE MODEM CENTRALIZED NETWORK-A DISTRIBUTED SYSTEM

Figure 2: The Modem Centralized Network — A Distributed System

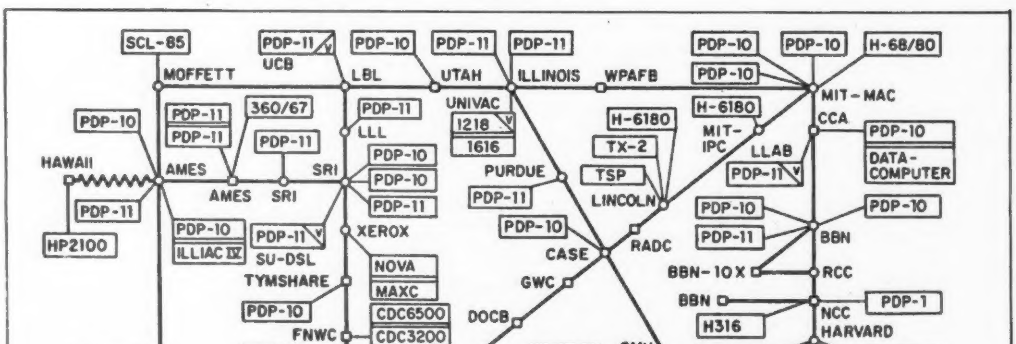

FIGURE 3: ARPA NETWORK, LOGICAL MAP, NOVEMBER 1974

Figure 3: Arpa Network, Logical Map, November 1974

(Continued from Page 39)

means that the storage of messages for retransmission is necessary only at the originating terminal. Storage at intermediate nodes is necessary only to provide buffering for short-term queuing conditions.

Each nodal switch in the packet-switching network performs all network communications functions for its hosts and is responsible for routing, monitoring the alive/dead status of its communications links and neighboring packet switches, controlling errors, preventing traffic congestion and monitoring time delays. Thus, the switch functions as a local network manager, deriving its information from the network and deducing the status of other elements within the system.

Network Management

Because local network management functions are so naturally performed by the network itself, the environment is provided for extremely effective "global" network management. This function is implemented through a network control center, which is vital to the operation of a reliable network.

The network control center appears to the network as another host. This host automatically collects, on a nearly instantaneous basis, status reports generated by each switch. It is thus able to alert operators rapidly when switches or communications lines fail, or when line errors or other fault conditions appear.

The network control center, therefore, helps to minimize the time required to identify and initiate corrective actions and helps to maximize system reliability and availability. This characteristic of rapid access to vital health and performance data is substantially different from most present networks, in which it is usually extremely difficult to monitor performance and to isolate trouble spots. The use of a control center in the packet-switched network is a management tool superior to that seen in other implemented communications network approaches.

Reliability Characteristics

The reliability characteristics of a distributed packet-switched network are totally different from those of other available network technologies. Because of adaptive routing capability, the distributed network's performance is not critically dependent on the perfect operation of each element. For example, after a link failure, the network is able to redefine network routes rapidly to adjust for the failure.

Typically, the distributed network design provides several alternate paths for network communications between important points. This allows the network designer to judiciously and economically add links so that the only limitation imposed on network reliability derives from the host and switches. In addition, arbitrarily high network reliability can be easily achieved by using redundant switches and ordinary communications lines.

An important characteristic of a packet network is that its many computers communicate through the use of common network languages and protocols. For example, the network nodes contain a virtual terminal protocol with which a variety of different terminals can find a common base for communications. The switches within the system allow the conversion of the local terminal language to the network virtual language and, at the destination, conversion into the language of the supporting computer.

Another major characteristic of packet-switched networks is the ability to achieve high utilization of the communications lines via the natural multiplexing ability of packet switches which, in this mode, perform much the same function as a concentrator. These two features, along with packet switching's potential to achieve reliability superior to more classical approaches, are largely responsible for the rapid commercial acceptance of the technology during the last few years.

Vendor Architecture

During the early 1970s, the majority of data communications systems were built by the mainframe computer vendors. These networks were generally developed to support application packages running on the vendors' hosts.

Obviously, data communications software systems developed by different manufacturers were bound to be incompatible. However, even the software systems developed to support different applications of the same manufacturer were generally incompatible with one another.

The result, throughout the industry, was multiple networks of incompatible terminals often connected to the same host and terminal locations. IBM was the first vendor to respond to this problem by announcing in 1974 its Systems Network Architecture (SNA).

Before the introduction of SNA, IBM had more than 200 communications products requiring 35 teleprocessing access methods and 15 different data link control procedures. The goal of SNA was to provide a unified approach to IBM networking by introducing a single standard host access method and link control procedure. The use of these standards would achieve terminal compatibility at the communications line level as well as independence between network devices (e.g., terminals) and host applications. This represented a major step forward in IBM's recognition of networks as a vital element of future computing systems.

SNA, as originally proposed and implemented, was a sophisticated architecture, designed primarily for centralized teleprocessing. Since 1976, SNA announcements have extended the implementation of the architecture to operate in a multihost environment by incorporating in the access method at the host and front end an Advanced Communication Function (ACF) and in increasing system networking capabilities.

The advantages of SNA are derived primarily from the use of a consistent, unified architecture in place of the ad hoc procedures of the past. The use of full-duplex terminals (based on IBM's

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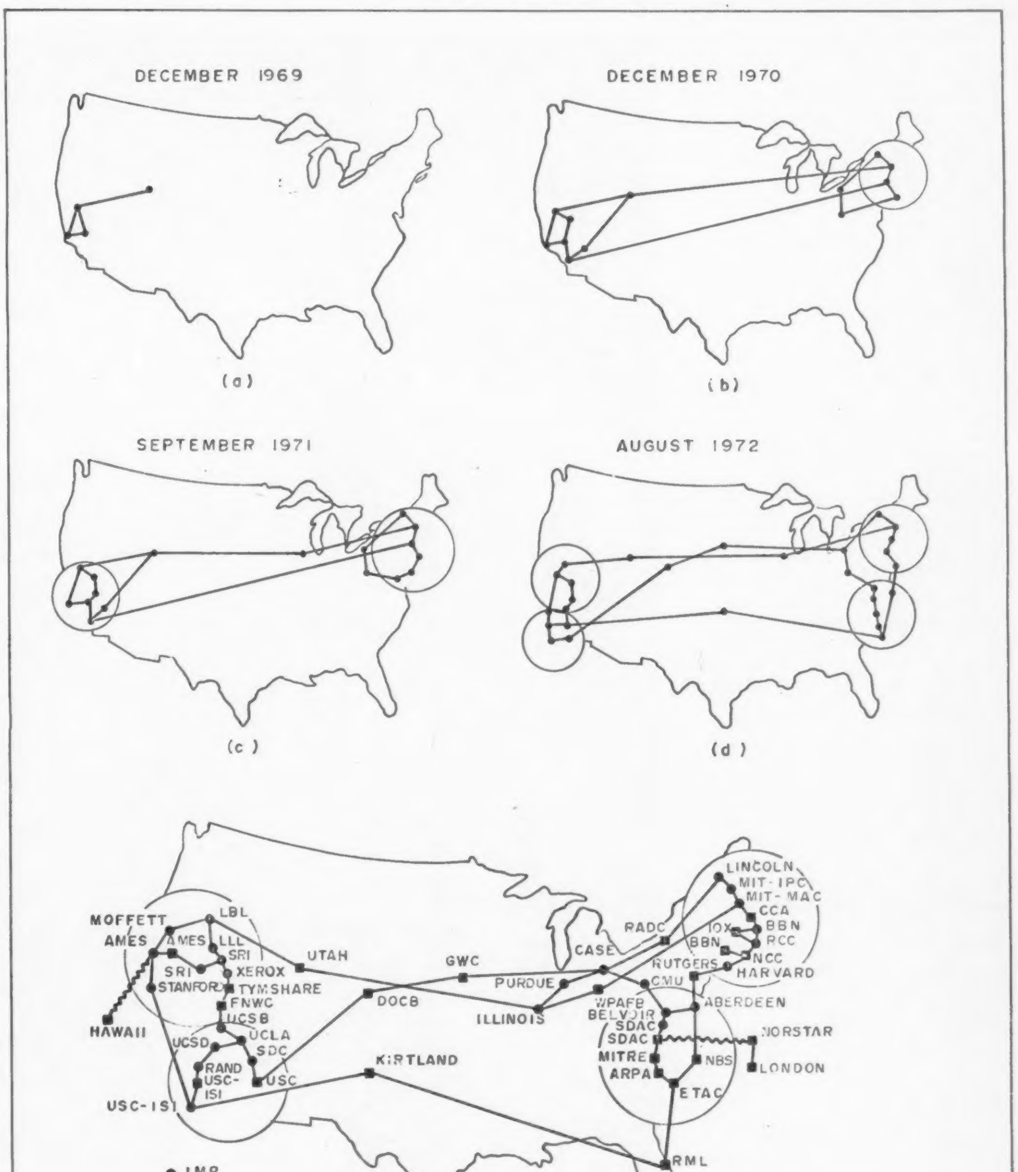

Figure 4: Evolution of the Arpa Network: (a) December 1969; (b) December 1970; (c) September 1971; (d) August 1972; (e) November 1974

(Continued from Page 41)
Synchronous Data Link Control [SDLC] protocol) allows more efficient utilization of communication lines, yielding fewer lines and lower line costs. Independence of applications and network hardware, including terminals, permits different applications to use the same terminals, reducing the number of terminals needed to perform a set of functions.

Furthermore, a somewhat reduced load on the main CPU can be achieved by offloading to front-end processors, controllers and intelligent terminals.

The original disadvantages of SNA related primarily to three factors: the costs of increased memory and processing at the host, the cost of upgrading from more primitive terminals and the conversion costs incurred by moving to a full SNA implementation. Moreover, IBM began its marketing of SNA by trying to convince its users to adopt SNA on a full-scale basis rather than through an evolutionary approach which would allow both SNA and non-SNA systems to co-exist. Developments over the last two years have reduced these disadvantages considerably.

First, IBM backed away from its original "revolutionary" approach by departing from its original intent to support only SDLC terminals in SNA systems and by extending the range of access methods supported under SNA. Both binary synchronous and start/-stop terminals are now accommodated, and it has become considerably easier to chart migration paths to SNA. (Additionally, the costs of new SDLC terminals from IBM are usually comparable to older bisync models.)

Second, the recent major reductions in the cost of memory and CPU hardware have helped reduce the penalty of greater memory and processing requirements.

Additional problems and issues associated with SNA have related to the strong influence and control of the network by the host rather than by a front-end or a general-purpose communications processor. This latter architecture makes it impossible to effect direct terminal-to-terminal communications without passing though an intermediate host.

Other problems which stemmed from the strong host involvement were the complex network definition procedure required when the original system software was generated, the operational difficulty of implementing changes to network structures and software and the difficulty of using SNA in a multiple-host environment. This last problem impacts reliability since current implementations of SNA do not have automatic alternate routing capabilities; it also inhibits the use of resources across software-defined host "domains."

SNA releases scheduled for 1980 and 1981 are addressing many of these problems and are introducing significant improvements. Thus, the SNA of the 1970s can be viewed as IBM's first step to develop a viable networking approach for the 1980s.

Since the introduction of SNA, many other vendors including Digital Equipment Corp., Burroughs Corp., Univac, Comten, Inc., Computer Communications, Inc., Raytheon, Data Services Co., Prime Computer, Inc., and Data General Corp. have all introduced their own network architectures. Some of these, such as DEC's Decnet, have already achieved considerable maturity. Others were only announced within the last year and are just beginning to be implemented.

Thus, the last decade can be considered as the period when vendors recognized the problems implied by large-scale data communication systems and began the activities required to address them. The fruits of these activities are yet to be fully realized.

Randon-Access Techniques

During the last decade, a sequence of experimental systems was built to allow many users to share the resources of single broadband channels. For example, the Aloha System was built at the University of Hawaii as an experiment in radio communications via packet switching. It consists of standard data terminal ground stations attached to radio front ends and a central station connected into a satellite ground station and also into Arpanet. Aloha forms the basis of a new technology being applied to both terrestrial and satellite radio data communications: random-access multiplexing.

In a random-access multiplexing scheme, the medium itself is the multiplexer. In its most straightforward implementation, random access is analogous to the situation where several nearby people speak simultaneously. When conflicts occur, a natural proto-

col causes a subset of these people to "retransmit" at a later time.

This scheme is similar to that which occurs when several terminals are connected to the same port on a front end or computer without using a multidrop polling discipline. If simultaneous transmissions occur, all will be distorted, and retransmissions will be required.

In a random-access multiplexing scheme, simultaneous transmissions are detected by requiring a positive acknowledgment for every correctly received packet of data. If packets collide, they will be incorrectly received and no acknowledgments will be generated. The senders must retransmit at later times.

If the retransmission schemes are properly handled, it appears from a number of analyses and tests that very high utilization of the channel is possible. The most sophisticated of the random-access schemes can yield data throughput of 90% or more of the channel capacity. Compared with the utilization of channels under conventional transmission protocols, major improvements in cost and performance are possible.

Random-access techniques are currently being studied for both extensive ground and satellite broadcast systems. One experiment now under way is investigating random-access transmission on satellites connecting users in the U.S. and Europe. This experiment is evaluating the validity and efficiency of a variety of different access and retransmission schemes and will, if successful, provide a major input for new satellite and ground station developments.

Another system, currently under development by Arpa, utilizes random-access transmission for mobile ground terminals. Called the Packet Radio System (PRS), it is aimed at providing efficient local access for mobile terminals, terminals in remote or hostile locations where cables are not feasible, terminals with high ratios of peak-to-average bandwidth requirements and terminals which require small bandwidth so hard-wired connections are uneconomical.

Studies have shown that packet radio provides a viable and cost-effective communications technique for local distribution in conventional, urban or suburban environments. One reason for PRS efficiency is that only the "active" terminal with information to send or receive impose overhead on the system.

This property is not true for most conventional communications schemes. For example, all terminals on multidropped lines must be polled periodically, whether or not they are active. Thus, a single broadcast channel in a PRS can accommodate many more terminals than an equivalent channel which uses polling.

It is interesting that random-access techniques are suitable for conventional leased-line systems, providing a superior channel protocol for many typical applications. Similar concepts have recently been employed to address the problem of intrafacility communications. Here, the capacity of a single broadband coaxial cable (or optical fiber) is shared among local computers or terminals. Several such systems (e.g., Xerox Corp.'s Ethernet) have been built and are now in operation.

Protocols and Standards

The past decade has seen major advances in the recognition of network protocols as a major area impacting network performance, compatibility and flexibility and as an important topic for study and standardization. Over the last few years, various groups have addressed the problem of developing standard levels of protocols and protocol standards within each level.

For example, committees working under the auspices of the American National Standards Institute (Ansi) and the International Standards Organization (ISO) have defined a working reference model which incorporates seven distinct levels of protocol as illustrated in Figure 3.

It is interesting to note that most net-

(Continued on Page 90)

Computing in the '80s:

Putting the Pieces Together

The computer industry's third full decade has come to an end. Most outside observers, not youthfully optimistic about the industry as we are, might see it as the end of a first generation. And if we step back, we would probably agree that many of the promises made a few decades ago can only now be kept.

In our second generation, we will finally witness the development of a new set of machines that are the logical evolution of the industrial revolution and its most recent electronic achievements — computers and microcircuitry. By the end of the next decade, people in the industrialized nations will be living and working in environments populated by intelligent machines (and some very clever toys) that have been made possible by a blossoming digital technology.

A comprehensive treatment of all that technology holds in store would fill a library. But a sampling of our future systems — large and small, short and long term — can be instructive.

In our first generation, we finally broke the technical and, therefore, the financial barriers to the widespread use of powerful computers. Our paramount focus was technological. Today's computers can process data at rates measured in millions of instructions per second. The cost of central processors and semiconductor memory has become very small.

But the goals are changing. Our collective fascination with raw data and how quickly it can be processed is beginning to fade. In the coming decade we will begin to focus on effectiveness rather than efficiency.

Four areas will be of primary importance in the 1980s. They are digital technology, software, office automation and information storage.

We have laid the cornerstones already. With our continued imagination and investment in evolutionary development, we will populate the computer landscape of the '80s with a new set of skyscrapers.

As we build on our digital technology, improve our ability to generate reliable software and provide convenient access to truly meaningful amounts of information, the greatest barriers to widespread use of computers in our homes and offices will probably be cultural rather than technical. A system with the capability of an IBM 3033 in every business office is not an unreasonable projection for the end of the decade. How effectively we will have learned to use it is the deeper question.

Digital Technology

At this transition between decades, the general public sees the digital technology evolution taking place on two fronts. The first and most visible is the continued penetration of microprocessor-based technology into devices we use in our daily lives. The second is the continued exploitation of digital technology to make computers of all sizes cheaper and thus far more available. Although the latter area will eventually have a greater impact on society and our ways of thinking, it is the less visible aspect of the digital technology evolution.

Today we avidly consume digital watches, give electronic games as gifts and occasionally splurge on the more sophisticated consumer goods such as microprocessor-based automatic cameras and stereo equipment. Our cars and homes will soon use microprocessors to reduce energy consumption. This type of digital technology will, in a short time, be used in a wide variety of ordinary applications, and it will be readily accepted because it improves the products that are an integral part of our daily lives: our gadgets become more functional, faster, more energy-efficient or better in some other way.

As Robert Noyce of Intel Corp. is fond of pointing out, we have already become consumers of an analogous device — the small electric motor — without ever realizing how prevalent it has become. Several dozen small motors can be found in the average house today. The microcomputer is the small electric motor of the '80s: we will all become consumers of the new digital technology.

The other front, the computerization of familiar systems, is far less visible. Even so, the changes possible are truly fascinating.

Computerized cable television is a prime example of this. Some cable TV subscribers have access to more than the morning news and first-run movies. In Columbus, Ohio, one company's subscribers participated in the first electronic survey on an important national event immediately after it happened — in "real time." A minicomputer behind the scenes allowed the cable-TV subscribers to voice their opinions on President Carter's energy message more quickly and more easily — obsoleting the traditional telephone poll.

This same technology applied on a more universal basis could allow "real-time" political decision-making based on instant analyses of the viewing audience's reaction. The politician would need to prepare several options that branched off from the main theme at points "polled." While this may be viewed as only a vast speed-up of poll-for-reaction techniques now commonly used, the broader social implications become clouded in issues of the influence of electronic journalism on the political process.

It is impossible to discuss digital technology of the future without mentioning the telephone system, which may well play the largest role in spreading consumable digital technology. It was recently reported that the French Postal Telephone and Tele-

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"Our collective fascination with raw data and how fast it can be processed is beginning to fade. In the coming decade we will begin to focus on effectiveness rather than efficiency."

By Lawrence Seligman

(Continued from Page 45)
graph is interested in developing a CRT terminal for integration with home telephones. Rather than a new esoteric form of communication, the purpose for this development is to use the terminals to eliminate the printing and distribution of telephone directories each year.

The development of such a "video telephone directory" is clearly feasible during the next decade. But certainly the availablility of a terminal in each home will result in many more important services and changes than the simple substitution of a "soft" directory for the present printed ones.

So far, we have seen only the tip of the digital technology iceberg. Widespead application lies in the 1980s, but its greatest impact lies well into the future. The two forms of digital technology will merge and become almost indistinguishable as the need for integrated systems and their potential becomes better understood.

The proliferation of systems in all areas of business and private life will continue to exert great pressures for more effective software development because the amount of software needed will easily outstrip not only our present manual resources but also any reasonably possible expansion of them. The development of higher level tools that facilitate the creation of application programs will be a crucial requirement in the computer industry. The macroeconomics of the industry dictates that programmer productivity be improved.

In the past decade, the total software cost for mainframe systems comprised about one-third of a user's DP budget. In the 1980s, there will be two trends. First, the manufacturer will provide more of the user application software. "Packaged" software will serve a large number of users. Second, the overall software content will substantially increase relative to hardware. Vendor-supplied software now represents about 50% of the price of a mainframe system, but will increase to about 90% by the end of the decade. Today, minicomputer software represents about 5-10% of the system price. By the end of the decade, it will comprise about 50% of the total.

Present-day software design methodologies require that programmers precisely instruct the computer system in
(Continued on Page 48)

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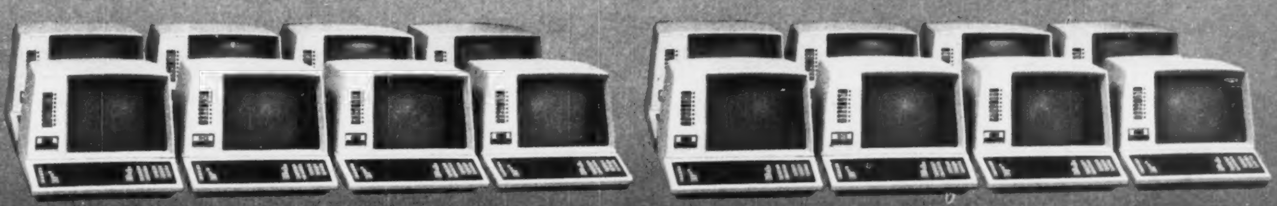

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how they want it to perform a series of operations. In the future, applications programmers using nonprocedural languages will be able to tell a computer what they want it to do, and the machine's operating system will execute the creation of programs semi-automatically.

This approach will aid systems effectiveness because it will allow programmers to focus on the problems, rather than the details, of the solution. The programmer will specify the desired format, files and reports — saying, in effect, "Here is the problem and here is the nature of the solution. Solve the problem." The computer system will then use its resources to generate the necessary procedures and create appropriate data base accesses.

When highly refined nonprocedural programming languages emerge, they will allow programming that is not restricted to a specific computer language such as Fortran. Instead, the software languages of the future will allow programming in narrow, but natural-language dialect — in languages that will be "comfortable" for both the programmer and the computer system.

Rudimentary examples of nonprocedural programming today include data base query facilities, screen and report layout facilities and automatic logging and indexing. In the field of artificial intelligence, programs have long existed to solve complex mathematical problems such as symbolic integration and to play strategy-based games such as chess.

In the '80s we are going to put it all together, to integrate the advances from the artificial intelligence laboratory with systems used in our daily business and private lives. The development of nonprocedural applications programming is a necessity if all of us are not to become programmers.

Office Automation

In the next decade, however, the greatest push on the computer system side of that evolution will happen in the same places where it has occurred in the 1970s: at places of business, and especially in the office.

The automation of a variety of office functions — ranging from business data processing to word processing and eventually to business information processing (when we, collectively, figure out what that is) is a prime candidate for the expansion of computerization in the '80s. The only restriction will be our ability to imagine new applications and our ingenuity to develop more approachable, useful and cost-justified systems. The productivity gains made possible by such systems are essential if we are to limit inflation, improve the work environment and, most importantly, improve our collective standard of living. We are responsible for providing the technology.

While the more popular, consumer-oriented forms of digital technology will have no trouble gaining widespread acceptance and use, the highest forms — computer systems — must be made reliable as well as inexpensive; moreover, their operation must be comfortable and their capabilities made accessible to the general public if they are to become truly widespread.

Over the coming decade, offices will install integrated, well-designed and accessible systems that rely on the advanced telecommunications and DP technologies that already exist. Office machines

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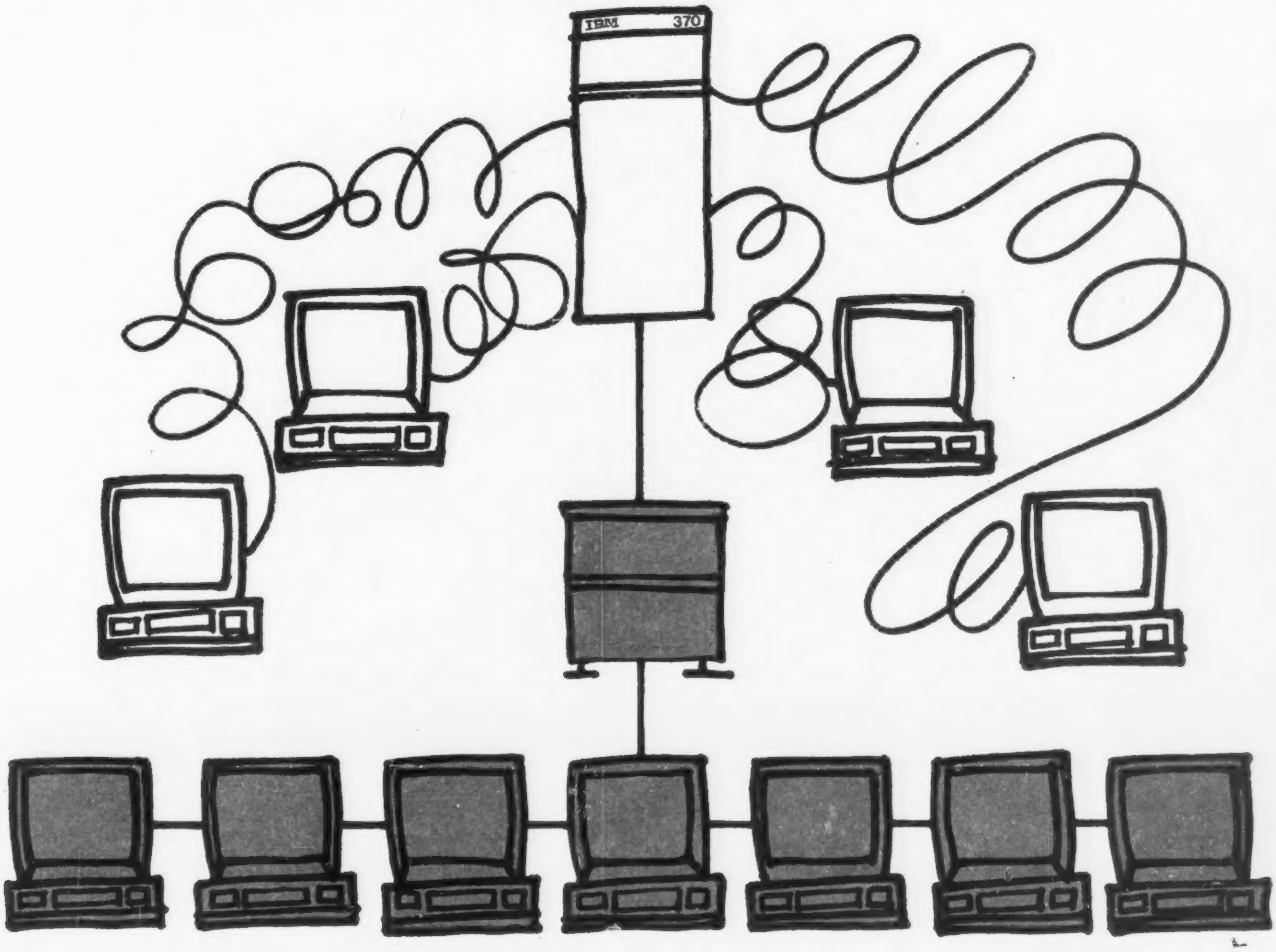

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SURVEYING THE '70s AS WE ENTER THE '80s

(Continued from Page 48)
will begin dealing with conceptual information and enter more into the decision-making process, at least at the highly detailed, routine level.

Today, computer users and manufacturers are exploring applications such as electronic mail. Electronic filing cabinets and integrated information research systems are not far off.

By the end of the '80s, we can expect to have a "talking typewriter" on our desk, not as a gadget but as a working partner that is integrated with the telephone, information storage, data processing and word processing systems. Not only will it be able to accept dictation, translating speech back and forth to a written format, but it will also be able to recognize and "understand" a wide variety of directions. Today, we have the underlying technologies in hand, for example, to recognize an individual's speech from a well-defined vocabulary, then to properly parse that into directives, to connect such directives into a report-generation process within a data base and print or read out the resulting text.

By the end of the decade, we will have learned how to make such systems useful. Based on reasonable assumptions of rates of change, it is likely to be another quarter century before the average office is very substantially automated. That eventual market — considering the present enthusiasm for new applications and the macroeconomics of the office — appears to easily exceed the $100 billion mark, in constant dollars. That is enough to solely support several companies the size of an IBM, Xerox Corp. or even Exxon. Our investment in the technology of our offices is presently almost two orders of magnitude smaller than we have made in our farms.

Information Storage

Whereas computers and computing are relatively inexpensive, the acceptable amount of storage needed for the wide-ranging applications of the next decade is still very costly both in relative and in absolute terms.

The necessity for vast information resources in systems of the 1980s will require greater activity on the part of storage technologists. We need to produce the kind of dramatic results in reduced cost, improved reliability and increased performance that we have achieved in digital circuitry. While the physics allows for continued significant improvements in both circuitry and storage devices, the greatest need over the next decade is in the creation of very large storage systems that are both efficient and effective.

One of the two major contributing factors to decreased information storage costs will be the steady extension of the boundary between the amount of storage that can be handled by purely electronic, rather than electromechanical, devices.

Ten years ago, one million bytes of storage was an amount that required an electromechanical storage device. Today, the boundary between electronic and mechanical storage is about 10 million bytes. In the late 1980s, the boundary could easily be pushed beyond 100 million bytes.

As the economic boundary between the two rises, the maximum capacity available on electromechanical storage media will also increase dramatically. Such storage, even by the end of the '80s, will still be necessary because of the

(Continued on Page 52)

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(Continued from Page 50)

vast amount of information we all would like to store and effectively access. The wide-band communications facilities necessary for intersystem communication will not have sufficient capacity to serve our needs from centralized data bases, except for time critical data.

Video Disk Technologies

The second factor to significantly decrease information storage costs will be the digitalization of video disk technologies, permitting the inexpensive publishing of huge amounts of slowly changing information.

The video disk offers an inexpensive, mass-produceable film medium read by a laser-based device similar to today's magnetic disk mass storage devices — except that each inexpensive "LP record" will store upwards of 10G bytes, or about 1,000 average size books.

New Possibilities

A collection comparable to the Library of Congress would fit into a large conference room and, with the right indexing and access methods, will be browsable in a way never before possible. A notebook size portable terminal, holding a few video diskettes, could probably contain all the textual and research material normally handed out in a typical college curriculum. It wouldn't be difficult to intermix an audio/video presentation. A picture, it turns out, is worth about 1,000 words.

We have already started on the road to this kind of easily available data storage. IBM and MCA, Inc. have formed a joint venture in the video disk business. Other more exotic technologies are also being explored. The changes to mass storage capacities and prices in the 1980s are going to parallel the changes we experienced in mainframe memory in the 1970s.

Greatest Challenge

The 1980s will be marked by the reliability and effectiveness of information processing. Effective, accessible systems will be the greatest challenge because they force change on the way things are done to accomplish a purpose or produce a result. A trend toward effectiveness will force designers to understand clearly, and in great detail, the way the system worked prior to computerization. Equally important, computer systems will have to exhibit the kind of reliability we expect of the telephone network: always non-operational somewhere in the larger integrated system, yet always in operation as viewed by most people. And they must be installed to make their use lead to more effectiveness and not necessarily more efficiency.

Telephone Story

The problems of understanding and utilizing all these highly capable technologies parallel the advent of an earlier one.

I am reminded of the story about the telegraph company executive who, having heard of the invention of the telephone, was ecstatic. The major benefit of the new technology, as he saw it, was to allow his telegraph operators to transmit messages by speaking to each other rather than using code. He could not foresee that the local "telegraph office" would become a universal, small device, installed in every home.

I suspect we, too, at the beginning of our second generation, do not really understand what we have produced.

Who Will Be Tomorrow's Information Czars?

By Edward J. Palmer

During the turmoil of the 1960s, computer scientists, including Dr. Ruth M. Davis, traveled the college campuses talking with students who were venting anger over "dehumanization" by computers. Satiric comment in the coffeehouses centered on the IBM card and "do not fold, spindle or mutilate."

Whether the lectures impacted opinion or not, the 1970s featured an explosion of the number and use of computers. And college campuses became the place where thousands of students delightedly discovered the computer as tool and toy.

As a complement to the evolution of hardware and development of software, this understanding of computer power by a large segment of society will crystallize the 1980s as the information decade. Canadian Marshall McLuhan articulated it best: computers in tandem with communication developments have collapsed time and space.

A computation that took X hours a few years ago takes X seconds today. A message that took X days to reach a maximum of the population yesterday takes X seconds today.

Such profound changes will show definite results in this new decade.

Power to the People

Computer power during the next 10 years will be in the hands of more and more people throughout the world. As in the history of automobiles and television, computer power to the people will also alter the very fabric of society.

Much attention has been given personal computers and microprocessors in everything from blenders to Cadillacs. More important, however, are the various ways the general public will plug into larger systems, more powerful machines both overtly and covertly networked.

Such concepts as electronic funds transfer (some based on home telephones), community antenna television (CATV), Viewdata and point-of-sale equipment are making everyone a computer operator. Ironically, the most interesting prediction is that such developments will "humanize" business and goverment activity with the individual!

Since the days of the colonies, American government could only handle people as groups. But now, through the proliferation of computers and the lowering of hardware costs, government can start interacting with citizens on an individual basis.

Of course, this means that John Public in Des Moines will get caught more easily for tax evasion. But it also means that government programs, pork-barreled on the assumption of treating herds of people, can be trimmed and tailored for real efficiency and economy.

When business gets over the marketing novelties, it too will discover the wonders of computer "humanization." The rocky road of the automobile industry is built today on serving the "masses."

However, through computer power (numeric control, distributed processing, robotics), it may be possible this decade to junk the mass production system and build cars presold and customized to each buyer's needs and desires, at a reasonable cost. Such retooled thinking would immediately settle an industry whose moans and groans now negatively impact the total economy.

All of this activity has affected the DP manager in significant ways that will translate into a revolution in the manager's traditional role in the business organization.

Basically, computers no longer need managing — systems and people do!

And the managing has grown more sophisticated and more encompassing as top management becomes involved in information processing while, at the same time, systems reflect a confluence of technologies.

Top corporate management will be facing increasing inflationary and regulatory pressure in the 1980s, pressures that will force some hard decisions on cost/performance and productivity. "State-of-the-art" in machines will no longer be as important as the careful acquisition of equipment and software inexpensively integrated and upgraded to meet the total organizational strategy.

Information processing management, or whatever a company wants the title to be, will need the talent and skills of the "generalist" tomorrow. Here the Data Processing Management Association has pioneered educational programs to provide much-needed resources in management techniques and personal development.

Merging Technologies

The more easily appreciated factor impacting the DP manager in the 1980s will be the coming together of numerous technologies, the blending of ways of handling information, that is breaking down the glass-enclosed computer center — forever.

That merging of technologies — data processing, word processing, telecommunications, micrographics and others — is a powerful catalyst. And the result is a new generation of information processing professionals — weaned on computers, matured by the evolution of systems, aged by the demands of runaway growth.

The current argument is over who shall direct the merging of technologies into tomorrow's total information system. Should it be a person from data processing? Or from word processing? Or someone with a telecommunications background? Should it be top management, with the aid of administration systems designers? Or a team?

Whatever the outcome of that argument, the main, the omnipotent point is that this confluence of technologies is a real-life indication of the maturing of information management as THE critical function of government, industry and business, a maturity that will be unlike the hardware improvements of the past 10 years.

Exploding that point to the global horizon, it is not impossible to see information as tomorrow's valuable commodity. Economies will no longer be based on products such as autos and oil and board lumber but on the generation, processing, storing and consumption of information!

Larger corporations are constructing complicated networks of computer power. Some companies, dedicated to transnational data flow, may become as powerful and influential as nations. Tomorrow's third world countries may be "information poor" instead of lacking in an industrial base. Small businesses, using minicompters, may overcome the trend toward bankruptcy.

And an old form of business may be seen again. Cottage industries could again gain visibility, with terminals in the home allowing people to "work" out of their homes.

Naturally this will place pressure on the information processing executive to be more visible within the organization and in the public sector. Preparing for the challenges of this decade means keeping top management informed of the DP function; being more involved in the total organization; and keeping up with all the competing technological forces impacting traditional data processing.

Edward G. Palmer is executive director of the Data Processing Management Association, Park Ridge, Ill.

We had a feeling our VS1 system wasn't performing the way it should. The lag in response time and inability to increase throughput indicated that our system was operating at capacity.

But my gut feelings said it wasn't. I couldn't be sure though, because I didn't have the means to evaluate our VS1 system.

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Thanks, guys!

DP in the '80s, or What is Your Applications Portfolio Like?

By Daniel D. McCracken

Computing is a victim of its own success.

The usefulness of computer applications has led to demands for more new applications than the present software development process can keep up with. The rapidly dropping cost of hardware and the introduction of microcomputers have led to the widespread use of computers in areas hardly thought of only a few years ago. And the explosion has barely begun. Everything done so far may pale, for example, before the revolution to come in the office, when before long every typewriter could have the power of what was a fairly large computer a mere decade ago.

The consequences of this explosion are not hard to see: Severe shortages of software writers, sloppily implemented systems and a furious search for better ways to develop applications software are among the more obvious.

What will the 1980s be like, when the hardware is thrown in "free" as an inducement to buy software? I see several possible trends.

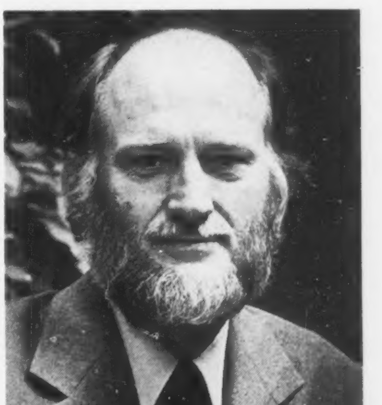
- The DP manager of the future will be primarily a package buyer. It's silly to write applications software if you can buy a package for less than the programming cost of doing it yourself — and save many months of lead time in the process. Typical questions when DP managers meet over cocktails will be, "What is your applications package portfolio like?" and "Have you imposed a limit yet on the number of outside vendors you'll deal with?"
- There will be a rapid switch to end-user application development, using packages, data base systems with easy-to-use high-level user interfaces and whatever else the researchers can dream up. This trend is already well under way. I know of a couple of major companies that have very large computers devoted to running applications developed by hundreds of end users without DP training, supported by a staff of roughly half a dozen consultants who give training courses and help with the tougher jobs. Software tools like Informatics, Inc.'s Mark IV and Pansophic Systems, Inc.'s Easytrieve, to name two older ones, and Information Builders, Inc.'s Focus, National CCS, Inc's Nomad and IBM's Query-by-Example, to name some newer ones, are already in wide use and are reportedly solid moneymakers for their vendors.
- It will become accepted that a "complete" set of specifications for a major system is excruciatingly expensive to produce, always incomplete, inevitably wrong and/or out of date before anyone signs off on it and is read by almost no one thereafter. Instead of going through this worse-than-useless exercise, people will turn to prototyping systems that let the DP expert and the end user actually communicate for once, in terms of a running model of what they are trying to talk about.

It is not true that software development is the only engineering "discipline" that never develops prototypes; rather, it is the only engineering discipline that delivers *nothing but* prototypes, that is, the first thing anybody can get running. As tools that make it possible actually to prototype a big system in a matter of days or weeks become much more widely used than they (already) are, this will change.

Career Opportunities

- There will be many career change opportunities for programmers. Today's programmers can apparently go on indefinitely doing what they do now, if they wish, but they can also switch into systems programming, where the shortage of people is extreme, or into consulting in specialized applications areas, among many other possibilities. The need for continuing education to support all of these changes will grow, creating with it an increased need for good training materials.
- *Some* solution will have to be found for the braindrain from the universities. The output of Ph.D.s in computer science — the future teachers of the great numbers of people who will be needed — is currently *dropping* as graduate students go off into industry without bothering to complete their degrees. I hope that the federal funding agencies will respond to the urgency of the problem and that industry will recognize both the obligation and the opportunity to help, by such measures as sabbaticals for people to teach for a few years or to complete their degrees.
- With so much work being done under such pressures of time and inadequate numbers of qualified people, there will be crashes. Perhaps literally. God forbid that it should take a major air disaster traceable to a programming error to bring it about, but one way or another the industry will have to assure the competence of its practitioners. Certification will have to come, unless licensing is forced on us first.

I'm not *positive* of all this, and I have a feeling lots more ought to be included in such a listing. I can predict with utter certainty, however, that the next decade will be exciting!



Daniel D. McCracken is president of the Association for Computing Machinery, New York.

The Rise of the Independents

By A.G.W. Biddle

User anticipation of forthcoming technologically advanced equipment led many companies to adopt a 'wait-and-see' attitude and suspend acquisition decisions. Of particular significance were the many rumors preceding announcement of IBM's 370 line. . . .

Many user organizations were unable to develop sophisticated information systems as quickly as they planned. Such systems often affect the operation of many departments in a corporate organization. Complex decisions of definition of requirements, development of systems segments, personnel training, implementation, input quality, output evaluation and related action often took longer to arrive at than anticipated.

One might think these words were intended to describe our industry in 1979. They were, however, penned by Frederick G. Withington in a 1970 analysis of the industry entitled *The Computer Industry, 1971-1975.* On the surface, it would appear that not much has changed during the past decade, but a great deal has. Because the past is prologue, I think it is useful to examine what really has changed and how, in turn, those changes will affect the industry and the user community during the decade ahead.

Evolution — Not Revolution

The biggest lesson learned from the 1970s is that the user can never again afford to be subjected to a traumatic reprogramming/reconfiguration effort similar to that represented by the transition to the IBM 360 generation. Today's architectures are based on modularity and what I would call horizontal and downward compatibility, that is, the ability to add additional power and capacity with little or no change in installed software and operating procedures. Probably two of the best examples of this today are the Datapoint Corp. Arc systems and the large-scale modular systems being offered by Magnuson Systems Corp. In the Datapoint system, increased power and capability can be added almost on a person-by-person or application-by-application basis, while in the Magnuson system, field enhancement can add memory and channels and/or increase CPU power from .4 million instructions per second (mips) to 1.3 mips with only minimal interruption in the user's jobstream.

On another front, the almost industrywide acceptance of the IBM *de facto* channel interface specifications has given the user a wide range of evolutionary system enhancement/cost reduction opportunities ranging from very advanced peripherals from Storage Technology Corp. to the highly regarded CPU offerings of Amdahl Corp.

For example, I know of one leading timesharing firm, Scientific Time-Sharing Corp. (STSC), that started with an all-IBM shop in the early '70s. To keep pace with customer demand, it initially replaced the IBM tape and disk drives with plug-compatible equipment from Storage Technology and Memorex Corp. Sometime later, on the other side of the interface, the firm replaced the IBM CPU with a more cost-effective Amdahl 470V/6. Since it had developed most of its own operating system (APL), the company had succeeded in increasing its data center's power and capacity by several orders of magnitude with no trauma — all because of the stable channel interface. Recently, in fact, STSC even added an IBM 370/148 on a plug-to-plug basis. All of this serves to illustrate that the user wants the ability to *grow his system to suit his company's needs,* step by step. Large segments of the industry have adapted their product and market strategies to this need.

Perhaps one of the least noticed, but most significant, shifts that occurred during the '70s was user management's recognition

Computer & Communications Industry Association

that the surface had only been scratched with respect to the things computer technology could provide in the way of better management decisions through timely information. The computer came to be viewed no longer as merely a numbercruncher for accounting problems, but as a vital contributor to all aspects of day-to-day operations. This changed perception was the single greatest contributor to the rapid acceptance of distributed processing and networking.

However, before any new approach can be implemented, some supplier must first foresee the need and have the capability available. In this instance, leadership did not come from IBM, who until only recently espoused centralization, but came instead from a whole host of independent suppliers. Comten, Inc. and Computer Communications, Inc. set the pace in front ends, while General Datacomm Industries, Inc. and other modem manufacturers showed Ma Bell how to move data. Telenet Communications Corp. and Tymnet, Inc. demonstrated that the user could build flexible, low-cost networks, using accepted international standard protocols. Tandem Computers, Inc. introduced a new approach to nonstop reliability in distributed systems that has been widely accepted by users who can ill afford downtime in today's environment. MRI Systems Corp.'s System 2000 data base management system demonstrated that the end user could have timely access to the information needed to manage — rather than wait in line for the development of a custom report program.

During the past decade, we also saw the application of DP technology to a host of other needs: Redactron and Lexitron pioneered stand-alone, CRT-based word processing; the application of minicomputers proliferated in a wide range of industries and applications with Datapoint, Basic/-Four Corp., Mohawk Data Sciences Corp., Wang Laboratories, Inc. and Prime Computer, Inc. moving most aggressively to provide simple-to-use, multiple-terminal systems for the smaller user. As we all know, the technology has also moved into the communications arena with sophisticated mini-based PBXs now being offered by companies like Rolm Corp.

Based upon the phenomenal growth of the companies I have mentioned, it would appear that the user was ready, willing and able to be weaned. Multivendor installations proliferated during the '70s, with literally thousands of user organizations, large and small, selecting freely from the state-of-the-art offerings of a wide range of innovative firms.

As one reviews the significant developments of the past decade, it becomes apparent that the dominant firms have not led in, but rather have been prodded into, providing the user with improved price/performance by the offerings of far more innovative and aggressive independents.

If one had to select the single most important event of the decade, it would clearly have to be Intel Corp.'s introduction of the microprocessor. As a result of the spirited competition between Itel Corp., National Semiconductor Corp., Mostek Corp., Texas Instruments, Inc., Fairchild and others, the state of the art in solid-state technology has moved forward rapidly. The cost of building CPUs and memory has plummeted, while speed and reliability have increased manyfold.

Today, the independent computer and peripheral manufacturers have timely access to the latest and best the domestic and foreign-based semiconductor industry has to offer.

(Continued on Page 58)

A.G.W. Biddle is president of the Computer & Communications Industry Association, Arlington, Va.

(Continued from Page 57)

It is no longer necessary for the user to hold his breath in fear that IBM will revolutionize computing as we know it and leave all other suppliers in the dust.

New Era

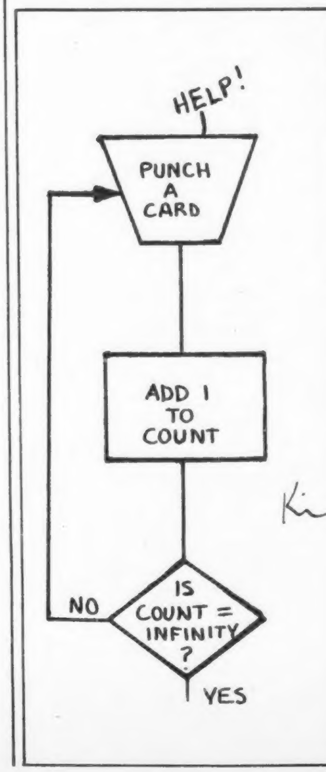
I look forward to the new year and the decade of the '80s with renewed enthusiasm for our industry and the opportunities that lie ahead. The technological foundations have been laid for new and exciting competition among suppliers and greater independence and creativity on the part of users. Although IBM managed to maintain its 60% to 70% market share throughout the '70s, the maintenance of its dominant position will become increasingly more difficult. In the past, IBM faced significant competition in only one industry sector or product area at a time — and usually could fend it off. Now it faces extremely capable, battle-proven competitors in virtually every product and market area. It may prove difficult — even for IBM — to be good at all things at all times.

We can anticipate the entry of a number of new players into the merged computer and communications industry; Xerox Corp., ITT, AT&T, IBM, General Telephone & Electronics, Northern Telecom Ltd. and Exxon will all be vying for market positions commensurate with their size and wealth. The European and Japanese majors will increase their efforts to penetrate the lucrative U.S. market. The smaller firms that survived the '70s are now poised for explosive growth in the '80s — they have proven themselves in the marketplace *and* to Wall Street.

In the meantime, our government leaders have finally realized that meaningful competition within free markets is far more conducive to innovation and efficiency than bureaucratic regulation and that the smaller firms are in fact the more innovative and dynamic. Wall Street has also realized that the new kids on the block are the ones with the explosive growth rates and exceptional market potential. We can anticipate a substantial increase in the flow of capital to new start-ups and to the established small and mid-sized firms in our industry.

The self-confident DP manager who is willing to make his own decisions and select the combination of offerings that is best for his employer will achieve some very exciting breakthroughs — including, I believe, elevation to the ranks of top management. The rewards will go to those who use our industry's goods and services to get the job done — not to those who merely play it safe while becoming increasingly locked in to the product and marketing strategies of a dominant vendor. To do so could well prove disastrous, because the convergence of computers, communications, word processing, voice communications, electronic message services and video storage and transmission will necessitate greater freedom of choice among hardware, software and service offerings, not less.

Speaking for the 70 member companies of the Computer & Communications Industry Association, I promise you that we will do everything in our power to ensure that you will have the widest possible choice among products and services that represent the best American technology can supply.



Telecommunications and Foreign Trade: The Dominant Issues of the '80s

By Vico E. Henriques

The issues that commanded a good deal of the computer and business equipment industry's attention for much of the past decade — telecommunications and foreign trade— more than likely will be the dominant issues of the 1980s as well.

In the 1970s, particularly in the last three years of that decade, the convergence of regulated communications services and unregulated DP and business equipment services neared the end of its evolutionary cycle and reached a reasonably well-defined market worth — by government estimates — some $50 billion.

What remains to be resolved is who will emerge as the principal players in the market, and whether they will be free to compete without an overlay of federal and state regulation.

If these and other questions are properly addressed by Congress, with a new Communications Act, and by the Federal Communications Commission (FCC) through its conclusions from its First and Second Computer Inquiries, the 1980s will witness a fierce but healthy competition that should produce unprecedented advances in computer and communications technology.

Flurry of Activity

As is often the case in history, the end of a decade results in a flurry of activity to bring issues into focus and set their future course. Such was the case with telecommunications and foreign trade.

After years of wrangling over the definition of telecommunications and whether dominant common carriers could compete in the market and under what rules, a kind of consensus emerged in 1979 — at least in broad strokes.

President Carter, in his September 1979 message to the House and Senate committees that have sweated over telecommunications reform since 1977, endorsed their work and declared that new communications legislation should embrace eight basic principles. Those eight points are well known by now and have met with little if any challenge from major factions in the telecommunications arena, including those of us at the Computers and Business Equipment Manufacturers Association (Cbema).

The main point of the president's message, it seems, was that competition should be encouraged, and fully competitive markets should be deregulated, while restrictions based on out-of-date market divisions should be removed. It is in how to implement this objective that disagreement arises.

FCC Position

FCC Commissioner Joseph R. Fogarty told Cbema's annual meeting in October that "we in government must resist the call and the impulse to regulate." Commenting on the proposed regulatory structure of telecommunications stemming from the FCC's Second Computer Inquiry, Fogarty noted that the Commission has tentatively decided to impose no restrictions that would prevent a carrier providing enhanced nonvoice communications services from also offering DP services and sophisticated terminal equipment through the same corporate structure of the resale entity.

At the same time, Fogarty conceded that the Commission has not decided "even tentatively on the degree of separation that should be prescribed between the underlying carrier . . . and the resale entity which would provide the enhanced services."

Cbema's position on telecommunications policy is simple. We believe regulation should be restricted to basic transmission services that do not alter a message but only act to transmit it from one place to another. All other services, as well as equipment such as terminals and PBXs installed on customer premises, should be offered on a fully competitive basis free of federal or state control.

At the same time, we believe all communications carriers should be free to participate fully in the information marketplace. This should be done, however, on an unregulated basis with a clear separation between regulated and unregulated activities. This would help ensure that the rate-payers of the common carriers' franchised services will not be required to bear costs and risks properly attributable to the carriers' unregulated services.

It is still too early to tell ultimately how the nation's communications policy will shake out. But it should begin to crystallize when the Congress produces new legislation to replace the antiquated 1934 law. We should see a successor to this 46-year-old law later this year or early in 1981 — one that is expected to emphasize telecommunications rather than broadcast issues. By the mid-1980s we should have a clearer picture of the future for telecommunications.

World Trade Outlook

The international trade outlook for our industry currently is in sharper focus — thanks to the landmark Gatt agreement resulting from the Multilateral Trade Negotiations (MTN) and the implementing legislation approved by Congress in 1979. In foreign trade, too, the 1980s could prove the pivotal decade for the rest of the century.

To be fully effective in opening world trade to genuinely free and fair competition, there must be persistent monitoring and follow-through by U.S. trade officials to ensure adherence to the MTN codes, particularly the government procurement code. In an era when at least 25% of the gross national product of most countries passes through public budgets, discrimination against foreign products by government purchasing officials constitutes an immense barrier to world trade.

It is vital that the codes implemented by our major trading partners — Japan, the European Economic Community nations and less developed countries — adopt the same open procedures in the bidding and contract awards process that characterize the U.S. government procurement code. We also hope that during the three-year review period for the code, it will be extended to cover procurement of services as well as products.

Government Intervention

Another area of intense trade interest during the '80s will be whether the U.S. government eliminates its ill-conceived intervention in commercial transactions between U.S. firms and their overseas customers in order to achieve foreign policy and military security objectives.

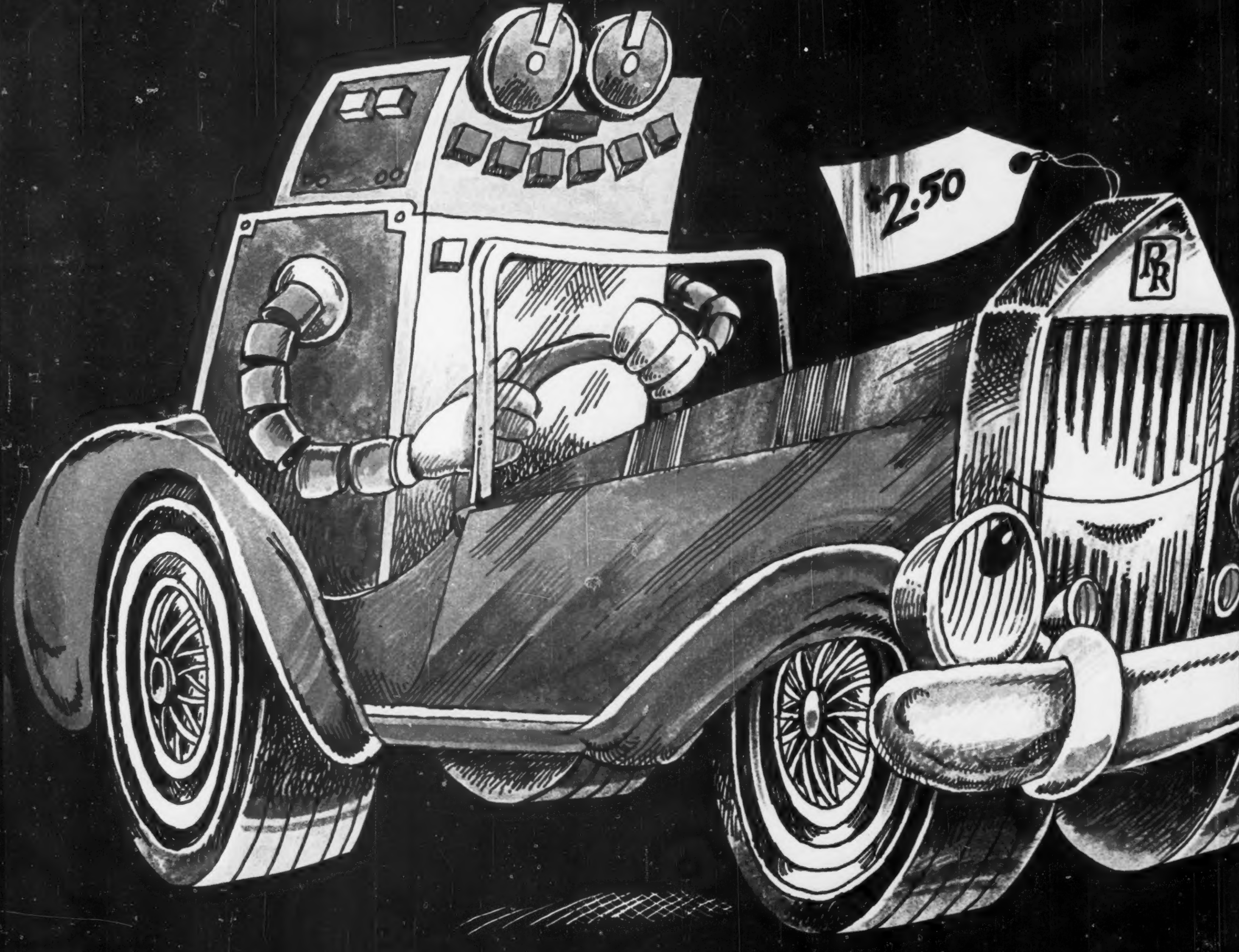
America's preeminence as the world's leading producer and exporter of high technology products and services is being seriously challenged by many industrial nations, especially Japan and West Germany. At a time when the nation's overall trade balance is in deficit of more than $30 billion, the U.S. must move to remove its own barriers to further more exports by U.S. business. In 1979, the positive U.S. balance of trade for computers and business equipment is expected to reach a record $4 billion.

It is encouraging to see the movement on Capitol Hill to reorganize the federal government's scattered trade activities into a separate cabinet-level Department of Trade, primarily to promote the U.S. exports. While Cbema is reserving judgment at this point on the wisdom of forming a central trade bureaucracy, the fact that the issue will undergo national debate in 1980 should keep foreign trade in the public spotlight where it belongs.

This industry has managed to maintain enough of a technological edge that it has not yet experienced the inundation of imports that have swamped and seriously damaged other more mature industries, such as textiles, footwear, steel and consumer electronics. Cbema is working to see that our industry does not suffer the same fate.

Vico E. Henriques is president of the Computer and Business Equipment Manufacturers Association, Washington, D.C.

"If the auto industry had done what the computer industry has done in the last 30 years, a Rolls-Royce would cost $2.50 and get 2,000,000 miles per gallon."



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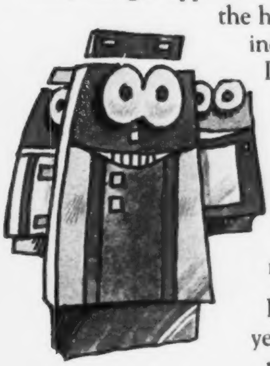
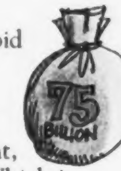
Most of our publications are weekly newspapers, because so many things happen so rapidly in the computer business (as the headline quote from a prominent industry executive makes so clear).



In only thirty years the industry has gone from the development of the giant Eniac system, through the tube-powered, water-cooled Univac I (the world's first business computer), to the incredibly cheap, battery-powered microprocessor.

But as unbelievable as the last 30 years have been, the next 30 will probably be even more incredible. Right now, IBM has begun delivery of a new computer series that will, by itself, provide four times as much processing power as all the previous computers delivered by the company. And they have announced a new "superconductor" that could improve computer speed and performance by a factor of 500 in the next seven years! It's hard to remember this is real science, not fiction.

This extraordinary increase in efficiency has led to a rapid expansion in computer use, as human ingenuity finds more and more applications for these powerful tools. So the market for computer products and services has turned out to be more elastic than most observers had thought. Worldwide expenditures are currently at $75 Billion, and growing by 20% a year.

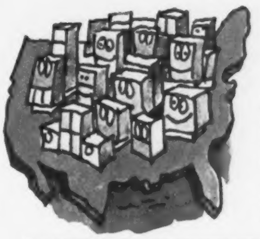


A constant flow of new products; rapid changes in technology; more and more new applications; and large and growing expenditures. It's an industry with a strong need for current, complete and accurate information. Which is where we come in.

Our oldest publication is *COMPUTERWORLD*, a weekly newspaper with a growing all-paid circulation in excess of 100,000 (quite an

increase from our modest 7,500 in 1967). *COMPUTERWORLD* serves America's computer users with the consumer-oriented, objective information they need. And it has become America's top business/professional publication, measured by advertising revenue.

Our newest publication is *COMPUTER BUSINESS NEWS*, a weekly newspaper for executives in the U.S. computer industry whose organizations are involved in the manufacture, integration and resale of computer systems. This is a relatively new marketplace which has grown up around the minicomputer and microcomputer, and which shows every sign of very rapid growth for at least the next decade.



The United States alone accounts for nearly half of the worldwide computer market, but billions of dollars are spent by foreign computer people for American-made computers and computer products. And our publications penetrate those marketplaces, too.

We are publishers of newspapers and magazines in the following markets:

Country	World Rank as Computer Market	Publication
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Australasia	9	*Australasian Computerworld*
Brazil	17	*Data News*

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- *Sistemi E Automazione (Italy)*
- *Computadoras Y Sistemas (Argentina)*
- *China Computer Monthly (People's Republic of China)*
- *De Automatisering-gids (Holland)*
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Calendar

Jan. 13-15, Miami — **The Copier Industry.** Contact: Institute for Graphic Communication, Inc., 375 Commonwealth Ave., Fourth Floor, Boston, Mass., 02115.

Feb. 4-5, Dallas — **Data Processing for Secretaries and Administrative Support Personnel.** Contact: Management Resources International, Inc., 6621 Electronic Drive, Springfield, Va. 22151. Also being held Feb. 14-15 in Denver and Feb. 28-29 in San Francisco.

Feb. 4-6, Bombay, India — **International Symposium on Data Communications and Computer Networks,** sponsored by the Computer Society of India and Technical Committee 6 of the International Federation for Information processing. Contact: Network 80, c/o Computer Maintenance Corp. Ltd., World Trade Centre, Cuffe Parade, Bombay 400 005, India.

Feb. 4-6, New York — **Introduction to Teleprocessing Software.** Contact: Datapro Research Corp., 1805 Underwood Blvd., Delran, N.J. 08075. Also being held Feb. 20-22 in Chicago.

Feb 4-6, Washington, D. C. — **Federal ADP Procurement: Hardware, Software, Services.** Contact: American Institute of Industrial Engineers, P.O. Box 3727, Santa Monica, Calif. 90403.

Feb. 4-6, New York — **Data Base Management Systems.** Contact: Datapro Research Corp., 1805 Underwood Blvd., Delran, N.J. 08075. Also being held Feb. 20-22 in Chicago.

Feb. 4-6, New York — **Turning Up the Corporate DP Function: A Management Primer for the '80s.** Contact: Datapro Research Corp., 1805 Underwood Blvd., Delran, N.J. 08075. Also being held Feb. 25-27 in San Francisco.

Feb. 4-6, Newport Beach, Calif. — **Data Processing for Non-DP Executives.** Contact: The Institute for Science and Public Affairs, 1370 Ave. of the Americas, New York, N.Y. 10019. Also being held Feb. 25-27 in Washington, D.C.

Feb. 4-8, New York — **Managing Telecommunications.** Contact: American Management Associations, 135 W. 50 St., New York, N.Y. 10020.

Feb. 4-8, Chicago — **Management Style: Self-Directed Growth.** Contact: American Management Associations, 135 W. 50 St., New York, N.Y. 10020.

Feb. 5-7, Washington, D.C. — **Office Automation.** Contact Mirconet, Inc., 2551 Virginia Ave., N.W., Washington, D.C. 20037. Also being held Feb. 19-21 in Washington, D.C.

Feb. 6, Fort Lauderdale, Fla. — **Invitational Computer Conference.** Contact: B.J. Johnson & Associates, Suite 203, 2503 Eastbluff Drive, Newport Beach, Calif. 92660.

Feb. 6-8, San Francisco — **Automating Your Office Today.** Contact: Datapro Research Corp, 1805 Underwood Blvd., Delran, N.J. 08075. Also being held Feb. 20-22 in New York.

Feb. 6-8, San Francisco — **Electronic Mail.** Contact: Datapro Research Corp., 1805 Underwood Blvd., Delran, N.J. 0-8075. Also being held Feb. 25-27 in Chicago.

Feb. 10-13, Miami — **Bank Telecommunications '80.** Contact: Operations & Automation Division, American Bankers Association, 1120 Connecticut Ave. N.W., Washington, D.C. 20036.

Feb. 10-15, Marina del Rey, Calif. — **Education Coordinator's Workshops.** Contact: Educational Services Division, Deltak, Inc., 1220 Kenington Road, Oak Brook, Ill. 60521. Also being held Feb. 24-29 in Toronto.

Feb. 11-13, Washington, D.C. — **Programming the 6502 in Machine and Assembly Language.** Contact: Continuing Engineering Education, George Washington University, Washington, D.C. 20052.

Feb. 11-13, Washington, D.C. — **Minicomputer Systems: Guidelines for Successful Selection, Acquisition and Operation.** Contact: Datapro Research Corp., 1805 Underwood Blvd., Delran, N.J. 08075. Also being held Feb. 25-27 in San Francisco.

Feb. 11-13, Washington, D.C. — **The Automated Office.** Contact: American Institute of Industrial Engineers, P.O. Box 3727, Santa Monica, Calif. 90403.

Feb. 11-13, Denver — **DP for Managers and Professionals.** Contact: Management Resources International, Inc., 6621 Electronic Drive, Springfield, Va. 22151. Also being held Feb. 25-27 in San Francisco.

Feb. 11-15, Denver — **Computer Contract Negotiation.** Contact: Brandon Consulting Group, 1775 Broadway, New York, N.Y. 10019.

Feb. 11-15, San Francisco — **Data Base Concepts and Design.** Contact: American Management Associations, 135 W. 50 St., New York, N.Y. 10020.

Feb. 12-14, Scottsdale, Ariz. — **Auditing, Security and Controls.** Contact: Advanced Computer Techniques, 222 N. Central Ave., Phoenix, Ariz. 85004.

Feb. 12-14, Toronto — **Data Communications Conference & Exhibition.** Contact: Witsed Publishing Ltd., Suite 2504, 2 Bloor St. W., Toronto, Ont. M4W 3E2, Canada.

Feb. 12-15, London — **The Third International Business Computing, Word Processing and Information Management Exhibition and Conference.** Contact: BED Exhibitions Ltd., Bridge House, Restmor Way, Wallington, Surrey SM6 7BZ, England.

Feb. 12-15, Kansas City, Mo. — **Computer Science Conference and Symposium,** sponsored by the Association for Computing Machinery. Contact: Computer Science Department, University of Kansas, Lawrence, Kan. 66045.

After Revolution of '60s

Lots of Quiet Gains Marked Decade

By Don Leavitt
CW Staff

1980. Another year gone by. Another decade gone by — except in the minds of purists who argue that since the year 1 was the first year, only the end of 1980 marks the end of the '70s.

In any case, 1980 marks the near-completion of 10 years editing this section, so it's impossible for me to resist the temptation to look back and recall what has happened in that time. What words describe what's happened in software? Exciting? Yes, but . . . Surprising? Not really. Revolutionary? No, certainly not that. Well then, evolutionary?

Yes! Evolution. That's the word. That doesn't mean there weren't dramatic changes — in hardware costs, in system types, in management thinking, in sources of software, in the way in-house development work was (pardon the expression) structured. But the changes were embedded in the flow of things and were not self-standing cataclysmic events.

The '60s had the revolution — the wrenching, sometimes devastating changeover from IBM 1400s to the new 360s with, for example, instructions in BAL that "reversed" the operands we'd gotten used to in Autocoder. But the '70s weren't that way at all.

Software Independence

Even the emergence and growth of the independent software industry — probably the most important thing to happen in these 10 years — hasn't been revolutionary. In mid-1969, IBM announced — as it often does — a self-evident but not generally realized fact: Software has a value of its own and should be separately priced.

Once the Great Gray Giant put price tags on its software, users began slowly to recognize they had to make choices. They began to see that there were costs to in-house development that might far exceed what a packaged solution might cost, with development costs shared by many users.

Analysis

And the whizzes with the brainy (sometimes zany) ideas for programs that might be useful to a number of people saw they might be worth something. So they told the world and the world responded, sometimes.

Package Revolution

Early on in the '70s, a package that had 20 or 25 users was a huge success. Now we see products with users numbered in the thousands. And yet the market research folks tell us that only something like 5% of the typical DP installation's budget goes to packages from independent sources. So you could hardly say a revolution has really hit hom in that area.

Language Standardization

Language standardization has come a long way in 10 years, but the impact has been a calming and not a devastating influence. Cobol and Fortran both have gone through a revision of the standards that existed in 1970 and are moving toward still another.

Cobol really has become the Common Business-Oriented Language the visionaries foresaw, and that has had a great deal to do with the growth of the software industry. Users of NCR Corp. gear, for instance, no longer have to work with Neat/3 (Does anyone remember Neat/3?). To a very large extent, one source program can be utilized on many different CPUs.

That has had a dual effect: clearly it opens the marketplace wider for the vendor, but it also has meant that DPers, as they migrate even to different equipment, can take along the software tools — report writers, for instance — that they know and enjoy using.

While the DP professionals were recognizing the value of common languages, the end users — the folks who (hopefully) get something useful out of these no-longer-so-strange boxes — were also recognizing that they too had common needs. And if a payroll/personnel/

(Continued on CW/2)

Data on OS/VS Production Work Cross-Referenced Under 'Axis'

HULMEVILLE, Pa. — A software system to provide cross-referenced system production information is available from Axis Software, Inc.

The system, also called Axis (for Autodoc-Xref-Index-Scheduling), will provide a summary of programs executed, information about external I/O data sets, formatted JCL and procedures listings, data listings from parmlib members, a restart table and a usage table for procedure symbolics, Axis said.

The system automates operational documentation from input JCL, tracks partition data set (PDS) updating, cross-references data set and PDS usage and provides a job-scheduling and tracking system, the vendor said.

Axis also provides utility functions including a scan and replace of PDS data, generic deletion of PDS members, condensed mapping of load modules and cross-referenced program subroutines, according to Axis.

Manual information can also be input to make documentation more comprehensive. Axis automatically reorganizes its own master files for performance and backup. It does file maintenance for all master files at one input point and supports multiple CPU-shared direct access storage device (Dasd) files, the vendor said.

Axis supports IBM OS, VS and MVS operating systems. Other features include preimplementation aids, the vendor added.

A perpetual lease of the system costs $6,500. After the first year, maintenance costs 18% of the existing purchase price, the vendor said from 18 Midway Ave., Hulmeville, Pa. 19047.

'Fers' Aids Fortran Debugging

ANAHEIM, Calif. — Software that lets Fortran programmers debug and correct their programs is available from Pilkerton International.

Called the Fortran Error Recovery System (Fers), the package will work with all IBM OS/VS systems as well as IBM Fortran compilers, the vendor claimed.

Fers is automatically activated whenever there is an abnormal end of a program. It analyzes the problem and gives the user information to correct the error, Pilkerton said.

The vendor also claimed Fers eliminates the need to look up messages, convert hexadecimal numbers or look at an Abend dump. Fers uses the CPU's power to complete those tasks, a spokesman explained.

The Fers package also displays information in the correct format. For example, floating-point numbers are displayed as signed decimal floating-point numbers. If the number is part of an array, the array name and subscriptions are also displayed, the vendor said.

Fers does not require CPU time during normal execution. No modification is required for existing JCL, and programmers need no special training, Pilkerton claimed.

Fers costs $190, the vendor said from Suite 600A, the Bank of America Building, 300 South Harbor, Anaheim, Calif. 92805.

Audio Response Offered

GREENWICH, Conn. — The Service Bureau Co. (SBC) has announced an audio response service that can be accessed by keying data and transaction codes into any 12-key Bell Touch-Tone telephone or equivalent rather than a conventional computer terminal.

Applications supported by this capability are limited only by the user's imagination, since the support is a bare-bones facility that must be tailored to become useful. The responses — created through a voice synthesizer — are "certainly not limited to verbal verification of whatever the user keyed in," a spokesman said.

Like the Rapidvoice service that has been offered by Rapidata, Inc. since 1972, SBC's audio response service is expected to be used particularly effectively in cash management — supporting, for example, the reporting of balances in accounts after each transaction.

Password Protection

The SBC offering includes password protection so that unauthorized personnel cannot extract information from sensitive files. It also provides a verbal list of instructions right after sign-on.

The SBC network is accessible over dial-up lines from most metropolitan areas in the U.S., Canada, Europe and Japan. Corporate headquarters are at 500 W. Putnam Ave., Greenwich, Conn. 06830.

Audit Programs Reviewed

PENNSAUKEN, N.J. — An analysis of 40 DP auditing packages is available from Auerbach Publishers, Inc.

Called 'Selecting Audit Software," the report outlines the general features and benefits of the packages and can be used as a tool in evaluating them, Auerbach said.

The report offers guidelines to help the DP auditor decide which package best suits his needs. Basic objectives — such as functionality, ease of use, cost, compatibility and support — are also offered, Auerbach said.

"Selecting Audit Software" also includes a section on software contract provisions and gives the DP auditor some tips on negotiating a contract.

The report is offered separately for $10 or as part of Auerbach's EDP Auditing reference service, which costs $140/yr, Auerbach said from 6560 North Park Drive, Pennsauken, N.J. 08109.

Docile Decade Aids Everyone

(Continued from CW/1)

pension package already existed that coped with Fica, EEO, Erisa, Osha, EPA, XYZ (XYZ?) and all, "why should we wait for your people in DP to write a program just for us?"

The end users have, in many cases, become far more significant in the DP scene — and perhaps both more demanding and more understanding at the same time. Upper management — the ulitmate end user — has obviously recognized its responsibility and forced the DP manager to live with cleaner, leaner budgets.

But the operational end users have taken minicomputers and small business systems to their hearts. Whether they use them at separate locations or as part of the growing move to distributed data processing, they've seen some of the problems the DP staff has faced, and perhaps seen through the mystique some DP operations still try to maintain.

The mystique goes back to the beginning, when programmers had to lay out sequences of instructions in infinitely detailed patterns to accomplish both the management of the computer resources and the logical handling of the data to do whatever task was needed by the end user.

Operating systems which matured nicely through the '70s and data base management systems may help resolve the first half of the problem. Structured programming and its later extensions into structured analysis and structured design should help out in the second half.

Hallmarks of '80s

"User-friendly" systems — query languages and report writers — that can be handled by clerical and managerial types without DP training apparently will be one of the hallmarks of the '80s. And that's not a bad thing even from the perspective of the programmers and analysts. Rather than feeling threatened by something that might take their jobs away, they may soon have the freedom to work on the hard problems that do require their skills.

Another development of the very late '70s that may make life easier for the DP professionals of the '80s seems almost a contradiction of the structured approach. Various shops have experimented very successfully with the prototyping of data base management systems. They install a sample data base that has applicability across many user areas and let the users "play" with it, making suggestions and asking questions before the DP staff does any hard coding that would lock the users into specific reports or ironclad data entry routines.

That's a reversal of the cry for firm requirements, signed off by users and staff, before a project gets under way at all — a project that might take so long to complete, its results are worthless to the users who asked for them in the first place.

If the '80s can avoid that problem, it should be a good decade.

Insurance Net Planned to Handle Range of CPUs

By a CW Staff Writer

WHITE PLAINS, N.Y. — An insurance industry group is planning a network that will operate among 800 insurance companies and their independent agents and will perform with virtually any type of computer.

The network is being designed by the Insurance Institute for Research, Inc. (IIR) and is mainly intended to simplify paper work that passes from agent to insurance company and lower communications costs, according to Jack Davis, IIR's vice-president of telecommunications.

The present system is inefficient, he said. A typical independent agent deals with between six and 12 companies, and each company has a unique system of paperwork and procedures it uses to issue policies and handle claims.

"An electronic replacement has to work in a complex environment," IIR's vice-president of systems, Arthur Tazelle, added. "Each insurance company now has its own internal DP, while many agents either have their own small systems or use service bureaus. None of these operations were designed to communicate with any of the others."

Study of 42 Agencies

To prepare for the pilot program, which will test the feasibility of connecting diverse computing systems, IIR recently completed a study of 42 insurance agencies. It measured phone, mail and in-person communications between the agents and the companies they represent and examined their paperwork structures.

The results showed a great deal of commonality in the type of information used by the agencies and indicated that it should be possible to fit the information into a standard format.

IIR also found that nearly half (46%) of agency phone calls took less than two minutes to complete and that the information could probably be passed in a shorter period of time in a network system.

Davis also indicated that in one and a half years of its existence IIR has developed an "extensive" data base on communication patterns between 19 member insurance companies and the 7,000 independent agents who represent them.

(Continued on CW/6)

Bell 212A Modems Rivaled

• Dial-Up Pair Aim To Reduce Costs

PALO ALTO, Calif. — A pair of dial-up modems for full-duplex transmission of serial binary data at either 300- or 1,200 bit/-sec become available this week as alternatives to Bell's 212A data set.

Prentice Corp.'s P-212A and P-212C modems offer automatic speed selection in the answer mode, which allows adjustment to transmission speed of the originating modem, according to a spokesman.

The benefit Prentice is emphasizing the most for these devices is cost reduction. "With a Bell 212A, there are substantial installation charges for both the modem and special telephone as well as ongoing lease payments for each, the spokesman said.

"The P-212A and P-212C can be purchased rather than leased and require only a [Bell] 502- or 503-type exclusion key telephone set or a standard business phone with

(Continued on CW/6)

• Triple Modems Suit Switched Nets

SUNNYVALE, Calif. — Switched network users are offered three modems in a stand-alone, originate/answer package this week for full-duplex transmission as fast as 1,200 bit/sec at remote terminals.

Racal-Vadic, Inc.'s VA3450 series includes six switched network originate/answer models, all combining a Bell-type 212A, Bell-type 103 and Racal-Vadic VA3400 modem and all federally approved for direct connection with computer systems under Part 68 of the Federal Communications Commission rules.

There is also a choice of originate or answer versions for leased-line applications, a spokesman for the vendor added.

A VA3450 at the remote terminal reportedly can call 212A, 103 or VA3400 modems with automatic identification of the receiver set. Racal-Vadic styles the VA3450 as a di-

(Continued on CW/6)

Communications Processor Compatible With LSI-11s

PORTLAND, Ore. — A programmable communications processor reportedly compatible with the entire Digital Equipment Corp. LSI-11 microcomputer family is available from Nortek, Inc.

The PCP-11L processor, based on the Z80A microprocessor, supports any mix of video graphics in 8-bit parallel, asynchronous or synchronous serial and color modes, Nortek stated.

In conjunction with an optional dialer interface, the PCP-11L can be programmed to provide auto-answer/auto-dial support for virtually any serial communications protocol, a spokesman noted. Most of the protocol overhead can be managed on-board, making the choice of formats virtually invisible to the host system, he said.

The processor is capable of handling data transfers faster than 48K bit/sec, according to the spokesman. Display resolution is 256 by 192 points in 15 colors, with textual information displayed in a 24-line by 40-column format.

A parallel communications port allows the PCP-11L to run with uncoded keyboards, touch screens, digitizer tablets and printers.

Control software for the PCP-11L can reside either on-board in nonvolatile memory or can be down-loaded from the host computer. Down-loading allows the processor to be reconfigured "on the fly" to meet changing user needs, the vendor explained.

The base price for the PCP-11L with parallel port, 2K-byte eraseable programmable read-only memory and 1K-byte random-access memory (RAM) is $525. A typical configuration for answer/originate serial applications consisting of a basic unit upgraded to a 4K-byte RAM plus dialer interface is $665 in quantities of 100.

A development version that includes the processor's principal options; a macro cross-assembler and a relocating linker that operate under DEC's RT-11 software; a down-line loader; a debug package; source code-resident monitor; and other features, including documentation, costs $1,950.

Nortek is located at 2432 N.W. Johnson St., Portland, Ore. 97210.

Digital introduces DEC Datasystem 540.

A powerful new business computer running the industry's most highly developed distributed processing software.

Our DEC Datasystem 540 brings a new level of power to mid-range distributed processing systems.

Built around our hot new PDP-11/44 processor, the D540 gives you an extra large memory (a million bytes) to support more terminals. Handle more processing more efficiently. And give you plenty of room to expand your application.

It also offers a Commercial Instruction Set and a new enhanced COBOL compiler that deliver powerful performance for your business programs.

And to make sure you get all the benefits of this increased capability, we've also increased the uptime with plenty of reliability features. Like a microprocessor-controlled ASCII console. Plus facilities for optional remote diagnosis for 24-hour-a-day, 7-day-a-week service with an average response time of less than 15 minutes.

But what really sets the DEC Datasystem 540 apart from ordinary computers is the distributed processing software that comes with it:

Digital's proven CTS-500 operating system.

And now we're introducing major new enhancements to CTS-500. Combined with the performance improvements of the D540, it means you get response times 50% better than with comparable systems.

You also get superior interconnect capabilities. Because with CTS-500, the DEC Datasystem 540 can emulate the popular IBM protocols, plus others as well.

In addition, CTS-500 is designed to be easy to use for a wide variety of jobs. For transaction processing, batch processing, word processing, and program development. All at the same time.

But the DEC Datasystem 540 is more than an exceptionally powerful mid-range business computer.

It's part of the broadest range of COBOL-compatible interactive systems.

The DEC Datasystem 500 family now offers the widest choice of COBOL-compatible systems in the industry. From the economical D530, through the D540, all the way to the high-end D570.

So you can put the right computer in every location without ever losing your original software investment. Or restructuring your distributed processing strategy.

And the D530 and D570 systems also offer the latest version of CTS-500. So you get faster response times and unequalled communications across the whole DEC Datasystem 500 family.

The new DEC Datasystem 540, from Digital. It's not only an impressive mid-range business computer in its own right.

But it keeps some very impressive company as well.

To learn more, just send the coupon.

☐ Please send me more information about the DEC Datasystem 540 and the rest of the DEC Datasystem 500 family.
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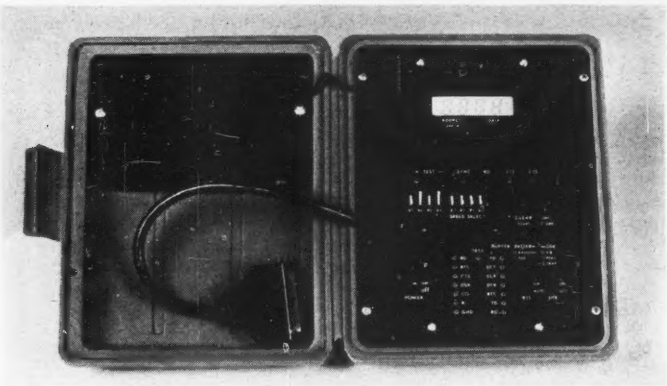


World's Smallest Data Analyzer?

Weighing just two pounds, Astrocom Corp.'s Maxichek data analyzer monitors and simulates the performance of data networks and related equipment such as modems and terminals. It costs $850 from the firm at 120 W. Plato Blvd., St. Paul, Minn. 55107.

Triple Modems Unveiled

(Continued from CW/3)

rect replacement for most 212A remote-terminal configurations "because, in addition to 212A and 103 modes, the remote terminal user also gets VA3400 capability."

How important is VA3400 compatibility? More than 50,000 VA3400s are now in the field, the spokesman maintained, adding that last October, Texas Instruments, Inc. said VA3400s would be incorporated in two of its Silent 700 teleprinter models, the 785 and 787. The VA3450 triple modems should have far less chance of obsolescence while those compatible communications devices proliferate, the Racal-Vadic source asserted.

The six switched network models of the VA3450 series are designated the VA3451P, VA3451S, VA3452P, VA3452S, VA3453P and VA3453S. The model numbers ending in "P" specify direct connection to the switched network via voice jack or programmable data jacks. Those ending in "S" specify direct connection via programmable data jacks only.

Prices for the VA3451s start at $900 each. The VA 3452s cost $850 and the VA3453s cost $825, Racal-Vadic said.

The vendor is located at 222 Caspian Drive, Sunnyvale, Calif. 94086.

Prentice Adds Dial-Up Pair

(Continued from CW/3)

an inexpensive voice data switch such as our VDS-100," he claimed. "Either of these is less costly than the Bell alternative."

The P-212C is distinguished from the P-212A by its microprocessor-controlled features. The former allows self-test during idle periods. "Constant modem condition review" is possible because "during every idle period, the P-212C automatically performs a self-test routine, a procedure that is accomplished in a matter of microseconds," the source asserted.

"If the modem fails any portion of the self-test, it automatically busies itself out," he added.

The P-212C also allows the user to busy-out a modem without interrupting communications or monitoring a line until it is free of traffic, the spokesman continued.

Other P-212C features include remote alarm control and a means of disabling automatic speed selection to permit manual selection of either 300- or 1,200 bit/sec rates.

The P-212A and P-212C are available in both stand-alone and rack-mountable versions. Stand-alone versions of those models cost $895 and $1,135, respectively. Prentice is located at 795 San Antonio Road, Palo Alto, Calif. 94303.

Net to Handle Range of CPUs

(Continued from CW/3)

From the data base, IIR has determined that, to make the system work, it will have to rectify the differing performance characteristics of "probably a couple of dozen minicomputer vendors and software vendors."

IIR will have to determine what language, protocol, line speeds and applications formats can be used by most of the companies involved. Although Davis conceded that some systems and formats will likely not be adaptable to the proposed network system, he said there is enough commonality to include a large portion of the organization's members if they realize what can be gained by "increasing their commonalities and decreasing their differences."

If all goes well, IIR thinks it can start the pilot sometime in the third quarter of 1980. Any number from five to 20 companies and up to several hundred agents will help the organization decide the practicality of putting together a communications system that will work with whatever computer equipment they own, IIR said.

In Five-Vendor Performance Face-Off

Library of Congress Tests Peripherals

By Jake Kirchner
CW Washington Bureau

WASHINGTON, D.C. — The Library of Congress recently found it easier than might at first be imagined to get five manufacturers of IBM plug-compatible peripherals to enter a performance reliability face-off for a half-million dollar disk drive contract.

A few companies, including IBM and California Computer Products, Inc., did balk at the "stringent 90-day on-site performance and reliability test," but there were only "a few grumblings" from Storage Technology Corp. (STC), Itel Corp., Memorex Corp., Telex Corp. and Control Data Corp., according to William R. Nugent, the library's assistant director for systems engineering and operations.

The library demanded 98% up-time for disk drives and 99% for control units, with no less than 125 hours mean time between temporary failures and at least 1,000 hours mean time between permanent errors. The units were loaded with various library data bases and accessed randomly during the normal course of library business.

Although one of the firms termed the reliability requirements "very stringent," Nugent said he considered them state-of-the-art and not unreasonable considering library needs.

However, he did allow that "it was the reliability spec that gave a lot of people a bit of unhappiness. A lot of them are willing to talk about it, but to actually run and to have errors counted was another matter."

Two Finalists

Although the library won't discuss the final grades for the test, industry sources said only STC and CDC were willing or able to meet the terms and complete the full 90-day evaluation.

When the smoke cleared, CDC had won a four-year, $450,000 contract for two 3802-8 storage control units, two 33502-A2 disk storage units with 635M byte/spindle and four 33502-B2 disk storage units with two 635M byte spindles each.

The unusual prebidding evaluation scheme has received the attention of several DP facilities around the country, according to CDC.

It noted that the General Services Administration, which oversees all federal DP procurements, has shown an interest in the library action.

Worthwhile Expense

One thing that is clear is that the library went to considerable trouble to make sure it was getting the peripherals it needed. It paid lease and maintenance costs to the five companies for the time their equipment was in the library DP center.

But the expense was "definitely worthwhile" Nugent said. "We got equipment with proven reliability ... we wanted performance-proven characteristics to make

(Continued on CW/10)

DDP User Survey Targets Trouble Spots

By Tim Scannell
CW Staff

CHERRY HILL, N.J. — Systems and application software, computer-to-computer compatibility and data communications facilities are the three major problems facing today's users of distributed data processing (DDP) equipment, according to a survey recently conducted by Management Information Corp. (MIC) here.

MIC's first annual user survey on DDP was released last month as part of its "Datacomm & Distributed Processing Report," which focuses on machine evaluations, manufacturers and even the future of DDP. The survey results were based on the responses of 118 system users from a wide variety of industries.

Nearly half of the respondents represent corporations whose annual sales run from $25 million to $1 billion, and more than 30% of the users polled have utilized DDP concepts for at least one year.

Top Honors

In the area of user satisfaction with equipment, MIC found that Digital Equipment Corp.'s Decsystem-10 and Decsystem-20 received the highest rating with a perfect score in ease of use and substantially high marks in performance, reliability, service and manufacturer's support.

Computer systems considered in the running for top honors were those that received five or more user responses and maintained an average score across the board. The ratings for each system ranged from 1 to 4, with 1 being poor and 4 signaling excellence, the report stated.

On the other hand, one of the machines with five or more responses that received a fairly low rating was IBM's Series 30. The processor scored below average in system reliability, ease of use, service and manufacturer support, according to the report.

Of the equipment rated in the survey, 85.1% had equipment manufactured by IBM, DEC, Burroughs Corp., Honeywell, Inc. and Univac, with the rest from assorted other vendors.

The survey also rated data communications equipment, giving the highest score to IBM's 3705 communications controller. Six users rated the controller as average or above average in all of the previously mentioned categories.

On the subject of problem areas in DDP, better than 44% of the users polled saw interfacing, data communications and software as trouble spots, while 7.9% labeled management of facilities as the next greatest problem. Fourteen percent of the users depicted either manufacturer support and service or system flexibility as trouble areas, and 4.6% targeted data capacity.

Future Visions

On the future of DDP, 42.4% of the respondents envisioned centralized large computers with multiple distributed microcomputers and minicomputers, while 24.6% pictured a central computer with remotely located terminals. Only 13.6% of the users thought that DDP would be solely made up of remotely scattered computers.

Finally, MIC asked users what they thought were the three top criteria in choosing a DDP system. Reliability was the overriding selection factor for 17.3% of the users polled, and 13.7% chose ease of use and cost. The least important selection criterion is upward compatibility, the report said.

MIC's "Datacomm & Distributed Processing Report" is published monthly and costs $85/year. Additional information is available from the firm at 140 Barclay Center, Cherry Hill, N.J. 08034.

"Gimme, gim

There's only one small computer that can give you your heart's desire: Sorcerer™ from Exidy.

You don't mean to be greedy. But you're part of the new "Gimme" generation with big plans for the future. You expect your computer to be flexible enough to keep up. Only one system on the market today can do that: the Exidy Sorcerer.

Z80 & Plug-in ROM Software Packs

The Sorcerer uses the popular Z80 microprocessor as its "brain-center." Combine this with Exidy's plug-in ROM PACs,™ and you've got a dynamite computing center right at your fingertips.

Our ROM PACs are special plug-in software cartridges that turn your Sorcerer into all sorts of different computer centers instantly. Just pop a STANDARD BASIC PAC™ into Sorcerer, and you're ready to program any application in high-level BASIC. Or plug in a DEVELOPMENT PAC,™ and you have a low-cost Z80 software development system costing less than $1700.

If words are your life, consider our WORD-PROCESSOR PAC.™ It turns your Sorcerer into a modern text editing and formatting system for less than $2600. This cartridge offers many benefits, including: automatic text wraparound, search and replace commands, and powerful macro programming.

And, to make it easy for you to put your own particular application software in ROM, we've also provided an EPROM PAC.™ It has sockets for four user-supplied EPROMs with capacity up to 16K bytes.

S-100 Expansion & 128 User-Defined Symbols

The Sorcerer was created to withstand "Gimme" attacks. It's designed to be the hub of a busy computing operation now, and tomorrow when your demands increase or change.

Sorcerer's standard features, such as high-resolution graphics, and the capability to define up to 128 of your own letters and symbols, give you an amazing flexibility to do things you simply can't accomplish with any other computer.

Our S-100 expansion unit lets you take advantage of the many useful S-100 peripherals currently available from dozens of manufacturers. And that includes everything from music and speech synthesizers for the hobbyist to appliance controllers for the home and the latest Winchester disk drives for small business computer applications.

It's also easy with Sorcerer to add on a printer, an acoustic coupler, or a modem, because our system has built-in parallel and RS232 Serial I/O ports (features normally offered as add-on options by most other small computer makers today).

Supercomputers Bolster Air Force Weapons Lab

By Tom Henkel
CW Staff

KIRKLAND AFB, N.M. — In an effort to beef up research capabilities in its Weapons Laboratory here, the U.S. Air Force recently agreed to a $9.6 million contract to lease two Cray-1 supercomputers through a third-party vendor, System Development Corp. (SDC).

The two Cray-1s — built by Cray Research, Inc. in Mendota Heights, Minn. — will replace a Control Data Corp. Cyber 176. The system will provide 450K, 64-bit words of main memory along with 4M 64-bit words of disk storage, on 25 CDC 844/21 disk drives during daytime operation. For nighttime operation, main memory will jump to 800K words with 16M words of disk storage, an Air Force spokesman said.

The two Cray-1s will operate as separate systems within the Weapons Lab. Both will use a CDC6600 CPU as a front end and both will be restricted to research and development operations. The first system is expected to be installed in February or March, and the second in September or October.

With the addition of the Kirkland Cray-1s, a total of 16 supercomputers will be installed. This makes the U.S. government the largest single user of the Cray-1, with CPUs installed at the Los Alamos Scientific Laboratory, a nuclear weapons research facility; the National Center for Atmospheric Research in Boulder, Colo., and two at the Department of Defense.

Although the Kirkland Cray-1s are the only ones to be used by the Air Force to date, Cray Research President John Rollwagen hopes they won't be the last.

"Hopefully, it's not a one-shot deal. [We would like] to be part of their long-term operations," Rollwagen said.

Despite Rollwagen's hopes for a continued relationship with the Air Force, the Air Force may not be as enthusiastic toward Cray.

Air Force sources say many feel the Cray-1 CPUs are too big for anything other than superfast number-crunching operations. The Air Force is leaning more toward Honeywell, Inc. or Burroughs Corp. systems to upgrade its aging computer systems, sources said.

The Air Force recently experienced problems with an experimental Honeywell Inc. 427M during a Nov. 6 test at the North American Air Defense Command (Norad) in Colorado Springs, Colo. [CW, Nov. 19]. In that case, the experimental system mistook a simulated missile attack as the real thing. Officials have not commented on the cause of the problems.

The Air Force and other government agencies have recently come under attack by both private and government officials for running antiquated systems.

Library Tests Peripherals

(Continued from CW/7)

sure that even though we were getting higher density [drives], which we needed, we would neither deteriorate our performance in the sense of queuing or delays nor deteriorate our performance in the sense of increased downtime. "We were unwilling," he said, "to pay either of those two prices for increased density. We have a pretty demanding user community and we just cannot afford to have downtime because of poor disks."

The DP center services approximately 1,500 terminals within the library, various congressional offices and the Patent Office. "It's essentially text data processing, [with a] heavy component of information retrieval," involving "some very large data bases," Nugent explained.

The library entered the procurement in order to upgrade and expand its 28G bytes of on-line storage. With rapidly growing access requirements, the DP center, based on Amdahl Corp. 470V/6II and IBM 3033 mainframes, was simply running out of floor space, and Nugent's staff wanted to move to double-density drive. With the CDC equipment, the library will be phasing out some of the lower density Itel and IBM drives now in operation.

"We have just been following a gradual path going from single density to double density. We had a few 3350s in, and what we wanted to see was how high we wanted to go without deteriorating the performance characteristics" of the system, he said.

Nugent said the performance test was unusual "in the sense of having several vendors side by side in the same computer room. To a lesser extent it's somewhat similar to bringing in a piece of equipment on a three-day trial and throwing it out if it doesn't meet your expectations. We just did this in parallel."

CDC, understandably pleased with winning the contract both on performance and price, said it knew of no similar test ever having been conducted for plug-compatible peripherals.

Such units are usually purchased on the basis of price alone. According to Bruce Johnson, CDC senior marketing representative for peripheral products. This can lead to a "lot of dissatisfaction" on the part of users later on because of reliability problems.

As for the Library of Congress test, "we welcomed it," Johnson said. "We felt from a reliability standpoint we had the edge."

For Small Business System Users

Independents Tackling Training, Support

By Marcy Rosenberg
CW Staff

LAS VECAS — What kind of training and support services can the small business computer user expect — and from whom?

The question seems reasonable and is one that potential customers should be asking. But there are no simple answers.

What complicates matters is that independent sales organizations (ISO) — systems houses, dealers, distributors and retailers — are figuring more prominently in small business computer manufacturers' strategies to move products and support an ever-expanding market of first-time users.

Many of these manufacturers view the ISO as not only a marketing channel, but also as a shoulder on which to drop the time-consuming and often costly burden of customer support and training.

These services can take many forms: software customization; on-going training on hardware, operating systems and applications programming; and hardware and software maintenance, to name a few. But the degree to which the ISO will assume the responsibilities that go into customer suţ port often depends on its financial and personnel resources, as well as on the product it sells.

Shared Responsibility

So after the customer support ball bounces back and forth between manufacturer and ISO, it often ends up landing in both courts, with the players ironing out a shared responsibility and drawing on each organization's individual expertise.

In one vendor's opinion, the division of responsibility between manufacturer and ISO can be clear-cut. Speaking at a recent manufacturer and ISO meeting here, George McMurtry, marketing services manager of Pertec Computer Corp.'s Computer Systems Division, said vendor strengths generally cover programming language training, operating system software training, hardware maintenance and applications program support.

He placed ISO strengths in the areas of hardware training and support, operating system software support, software customization and applications software installation and training. However, depending on the resources of each company, the degree of customization required and the expected profitability of the sale, some of these responsibilities fall into gray areas.

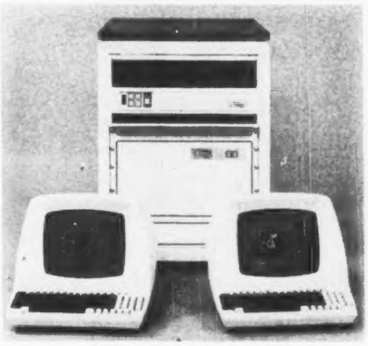
Particularly for training, the question boils down to how profitable that service can be. With this in mind, McMurtry suggested the following guideline: High-priced, low-volume products often spell the need for personalized training and extra hand-holding from the ISO; for low-priced, high-volume products, less personalized training at the vendor's site suffices.

As for hardware support and maintenance, "if the vendor isn't supplying it, the ISO must," he stressed, adding, "The ISO can't go to a third party unless it is dealing with products from a major manufacturer."

(Continued on CW/14)

Zilog Offers Turnkey Systems, Two MPU-Based Subsystems

CUPERTINO, Calif. — Chip-manufacturer Zilog, Inc. has plunged into the already heavily populated small business computer arena by introducing two general-



The Zilog MCZ-1/70

purpose turnkey systems and two modular microcomputer subsystems.

The firm also sweetened its computer deal by unveiling a multiterminal Cobol option for the new computer systems that permits up to five users to simultaneously access the same data or perform separate operational functions.

The desktop MCZ-1/50 and rack-mounted MCZ-1/70 include a Z80 microprocessor with 64K bytes of random-access memory, an interrupt-driven console capability and a floppy disk controller. The 1/50 is packaged with a CRT terminal and integral dual floppy disk drives, providing a total of 600K bytes of data storage. The system can be expanded by four more floppy disk drives and/or four 10M-byte cartridge disk drives, a spokesman said.

(Continued on CW/14)

DG Eclipses Get Disk Subsystem

WESTBORO, Mass. — Data General Corp. has introduced a disk subsystem for its Eclipse S/250, C/350 and M/600 minicomputers that provides up to 277M bytes of storage per drive and can handle more than 1G byte of data.

The Model 6122 subsystem operates on minicomputers equipped with DG's burst multiplexer channel. It uses removable disk packs to facilitate security and off-line storage, a spokesman said.

The subsystem has a higher effective seek performance ratio than DG's 190M-byte subsystem, covering 92M bytes of data in the same amount of time it takes the 190M-byte unit to span 63M bytes.

The disk pack formats data in 35 sector/-track; each track is 512 bytes. Data is transferred at a rate of more than 1M byte/sec, the spokesman claimed.

The disks are fully supported by DG's Advanced Operating System (AOS) and Real-Time Disk Operating System (RDOS).

The 6122 incorporates a two-board controller, a rack-mounting adapter with a self-contained power supply and all the necessary cables. It can accommodate up to three add-on disk storage drives.

With a single disk drive and pack, the subsystem costs $38,500. The Model 6122-A add-on disk drive sells for $33,500 and the 6062-B dual-port option is priced at $8,000, DG said from Rt. 9, Westboro, Mass. 01581.


Brand Preference Study 1977
Brand Preference Study 1978
Brand Preference Study 1979
Brand Recognition Study 12th Edition 1978
Brand Recognition Study 13th Edition 1979
SILENT 700
Model 733 ASR Data Terminal
SILENT 700
Model 743 Data Terminal
SILENT 700
Model 745 Portable Data Terminal
SILENT 700
Model 781 RO Printer
SILENT 700
Model 783 KSR Data Terminal
SILENT 700
Models 785/787 Portable Data Terminals
BRAND PREFERENCE
THERMAL
SILENT 700
Model 763 Bubble Memory Data Terminal
SILENT 700
Model 765 Portable Bubble Memory Data Terminal
OMNI 800
Model 820 KSR Data Terminal
OMNI 800
Model 820 RO Printer
OMNI 800
Model 825 KSR Data Terminal
OMNI 800
Model 825 RO Printer
OMNI 800
Model 810 RO Printer
MEMORY
IMPACT

Best Sellers.

TI's data terminals top the list with industry leaders.

TI data terminals have been the industry's choice for years. Now businesses worldwide are giving TI's *Silent 700** and OMNI 800* Electronic Data Terminals great reviews for performance and low cost.

Every *Silent 700* model features TI's field-proven thermal printhead for 30 characters-per-second virtually silent printing. The Model 733 is ideal for businesses needing the performance of dual magnetic tape cassettes with off-line storage. The Model 743 Keyboard Send-Receive Data Terminal tops the list for low-priced data terminals and is ideally suited for stationary computer input/output applications. And our Model 763's built-in nonvolatile bubble memory recalls locally-stored data, cutting down on computer-use time.

Businesses on the move are choosing *Silent 700* Portable Data Terminals as compact traveling companions. The Model 745 Portable Data Terminal weighs only 13 pounds and uses a standard telephone and electrical outlet to communicate with a host computer. The lightweight Model 765 Portable Bubble Memory Data Terminal takes orders all day, and can then save on communication costs by transmitting at night when phone rates are lower.

The new 780 Series Data Terminal models feature TI's state-of-the-art dual-matrix printhead for 120 characters-per-second virtually silent thermal printing.

The OMNI 800 Family impacts businesses with a collection of standard features, like optimized bi-directional printing speeds of 75 or 150 characters-per-second, and adjustable wide carriages that take the effort out of handling multiple forms. From the reliable Model 810 RO Printer, known for quality performance, to the flexible Models 820 KSR and 820 RO, the OMNI 800 family provides quick responses to your impact printing needs. Rounding out the family, the cost-efficient Models 825 KSR and 825 RO offer the novel feature of upgradability.

TI is dedicated to producing quality, innovative products like the *Silent 700* and OMNI 800 Electronic Data Terminal families. And TI's hundreds of thousands of data terminals shipped worldwide are backed by the technology and reliability that comes from 50 years of experience in the electronics industry.

Supporting TI's data terminals is the technical expertise of our worldwide organization of factory-trained sales and service representatives. And TI-CARE†, our nationwide automated service dispatching and field service management information system.

That's why TI has been appointed the official computer and calculator company of the 1980 Olympic Winter Games.

Every member of TI's best-selling *Silent 700* and OMNI 800 families is ready for immediate off-the-shelf delivery. And our nationwide sales representatives and Authorized Distributors can advise you about quantity discount structures for additional cost savings.

For more information, contact the TI sales office or Authorized Distributor nearest you, or write Texas Instruments Incorporated, P.O. Box 1444, M/S 7784, Houston, Texas 77001, or phone (713) 937-2016.

TEXAS INSTRUMENTS
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We put computing within everyone's reach.

Independents Taking On Training, Support

(Continued from CW/11)

Perspective from the horse's mouth on what the ISO's role in customer support should be was offered by an independent dealer for Durango Systems, Inc. gear, California Business Systems, Inc.

Customer support priorities at California Business Systems — which has installed 39 systems since February to first-time users, contributing to an expected $2.5 million in sales this year — fall into the following hierarchy: "Our first priority is to the installed customer to get him independent; second is to users with equipment on order; and third is to go after new orders," President Robert Grote commented.

After an order is placed and a deposit accepted, the firm begins a clearly defined customer support procedure:

- It holds what Grote calls a "buyer's remorse session," during which time executives at the user organization are told, "Here's what you get, when you get it and when you pay for it."
- It brings operators to California Business Systems to train on the hardware. Grote describes the "classic" operator as "a middle-aged woman who hits 'L' for '1' and shakes at the sight of a computer." A secondary goal of this session, then, is to allay any fears of the machine, often by never even using the word "computer."
- At time of delivery, it helps the customer begin converting its own files, say, from ledger cards onto disk. This usually takes one hour.
- It helps the user enter and purge its data, typically a two-hour project.

Because of the time and extent of customer support required for the first-time user, the Durango dealer never implements more than one application at a time, Grote explained. And because of the costs involved, California Business Systems adheres to certain policies to make sure that customer support becomes not a profit drain, but a money-maker.

For example, the company trains users in-house for the first application only; training for subsequent applications is on an on-site, call-in basis. And for continual on-site training, the firm charges customers hourly fees averaging $600 for the base system and $50 for applications.

Zilog Offers Turnkeys

(Continued from CW/11)

The MCZ-1/70 also has a CRT unit and either the dual floppy disk drives or cartridge

Both systems include an advanced operating system, text editor, debugger, Macro assembler and file management software, and both provide either a single-terminal or multiterminal Cobol run-time interpreter for executing previously compiled object modules.

Designed with expansion in mind, the desktop MCZ-1/-20A and rack-mounted MCZ-1/25A can be used as "building blocks" for general-purpose systems that are geared for business and industrial applications, the spokesman continued.

Multiterminal Software

Finally, Zilog's Multiterminal Cobol program offers most level-one and many level-two features of the 1974 Ansi X3.23 Cobol standard, and can accommodate a number of software routines generated on minicomputers or mainframe systems, the spokesman claimed.

Geared for up to five users, the software requires the addition of an optional serial interface board (SIB) to any of the previously mentioned computers. The SIB permits the attachment of four extra terminal stations to the computers, the spokesman explained.

Prices for the MCZ-1/50 microcomputer start at $8,460 while the 1/70's costs begin at $18,240. The modular MCZ-120A and MCZ-1/25A sell for $6,990 and $16,925 and up, respectively. The multiterminal software option is priced at $950.

Additional information on the computer systems and quantity discounts are available from Zilog at 10460 Bubb Road, Cupertino, Calif. 95014.

Look Outside Industry for Executives

SAN DIEGO — Medium-sized computer firms must begin tapping managerial talent from outside the industry in order to attain dynamic growth during the 1980s, according to Lester B. Korn, president of the executive search firm of Korn/Ferry International.

Companies can no longer look to IBM and other major computer firms as the training ground for managers, Korn warned industry executives attending a meeting of the Computer & Communications Industry Association here recently.

Moreover, Korn noted, salaries for executives in the computer industry, particularly in medium-size firms, lag behind those in other industries.

"Your companies must make the delicate and difficult transition from scientific entrepreneurial management to professional, multidisciplined management in the 1980s. "Without such an infusion of qualified managers, your industries will not mature successfully and will be susceptible to unfriendly takeovers, forced mergers and increased difficulty in raising capital funds," he warned the group.

Executive Searches Double

Some leading companies have recognized this dilemma, Korn said, pointing out that the number of requests made to his firm for executive searches in the computer and high-technology fields has doubled in the past five years. In 1975, these searches accounted for 5% of all searches, but today represent 10%.

Among recent Korn/Ferry searches have been 12 president or chief executive officer assignments, each averaging in excess of $200,000 including option values.

Besides scientific entrepreneurial executives, professional managers outside the computer industry should be considered for top slots, Korn suggested. He sees the industry benefiting from human resource professionals, consumer products marketing and sales executives, multinational finance directors and even managers with classical engineering backgrounds from other large industrial firms.

However, to attract qualified executives to the industry, salaries will have to rise from levels which today trail compensation in other industries. "Historically, the computer and communications industry has relied too heavily on stock options, which have often proved illusory, as a substitute for cash compensation," Korn said.

Furthermore, as more medium-size firms attempt to enter international markets, they encounter difficulty in coping with the salary demands of overseas executives.

Korn urged the industry to raise its base salary and bonus arrangements and tie them to increased profits.

Despite Service Bureaus' Opposition

FCC Approves Three U.S.-Tokyo Nets

By Phil Hirsch
CW Washington Bureau

WASHINGTON, D.C. — Three new packet-switched communications services between the U.S. and Japan have been authorized by the Federal Communications Commission despite statements from U.S. service bureau operators that the action will help push them out of overseas markets.

The FCC ruling concerns RCA Global Communications, Inc's Low-Speed Data Service, ITT World Communications, Inc.'s Universal Data Transfer Service and Western Union International's Data Base Service. All three route messages at 9,600 bit/sec through packet switches and voice-grade satellite or cable circuit between the U.S. and Japan.

Private-line or dial-up telephone extension circuits within each country connect the user's premises with the international carrier's switching center. In the U.S., a customer can also use GTE Telenet Communications Corp.'s Telenet or Tymshare, Inc.'s Tymnet packet-switched networks to link its terminal with one of the three U.S. international carriers' switching centers.

According to critics of the FCC decision, the ruling threatens to increase the costs of doing business and reduce prospective markets worldwide for U.S. vendors of computer/communication services.

In briefs presented to the FCC, the service bureau operators said the three new services are part of a worldwide effort to replace conventional private-line tariffs with volume-sensitive offerings that limit transmission speeds and charge for usage according to the volume of traffic sent. (A user who leases private line, by comparison, pays the same amount no matter how much data it transmits, also, the user is free to employ data compression, conditioning and other enhancements to increase throughput.)

The service bureaus are not opposed to volume-sensitive tariffs as such, they told the commission; their basic goal is to assure that conventional leased circuits remain available for those users which prefer them.

If foreign communication carriers — the postal, telephone and telegraph (PTT) administrations — restrict or eliminate these circuits, according to service bureau operators, it will increase costs significantly for U.S. firms that market computer/communication services abroad. In addition, the services won't be as good because the new facilities employ carrier-specified communications protocols designed for a wide spectrum of appications and thus can't be tailored to individual needs, the service bureau operators charged.

As a result, users will end up paying more for less than they're now getting, but the carriers will end up earning more for less than they're now providing.

The FCC, however, refused to buy this argument.

Pointing out that the three services to Japan are follow-ons to offerings authorized previously between the U.S. and other

(Continued on CW/16)

F&S Sees One Million Packages Sold to Small Business in '80s

NEW YORK — The market for independent software packages for small business computers has reached a $241 million annual level and will increase to $700 million by 1988, according to a report by Frost & Sullivan, Inc. (F&S).

More than one million software packages will be sold in the next decade; unit sales will increase from the current 60,000 packages to 65,000 in 1980 and then to 185,000 in 1988, the research firm predicted.

The report indicated that cumulative shipments will be distributed to user markets in the following quantities:

- Retail: 349,500.
- Wholesale: 251,000.
- Manufacturing: 194,000.
- Services: 98,000.
- Transportation: 93,000.
- Construction: 73,500.
- Insurance: 44,500.
- Banking: 11,500.

The microcomputer market will offer the largest sales potential for packaged programs, totaling 870,000 and valued at $1.9 billion over the next 10 years, F&S said. This market accounts for 78% of the potential total in units.

The stand-alone minicomputer-based system or one with a few terminals is the most viable segment, accounting for 18% of the market, the report found. Large, multiterminal minicomputer systems for which a software package typically costs $15,050 will account for 4% of unit sales for the entire market.

Hardware manufacturers are not adequately serving the user in respect to software quality, variety or cost, according to the report. Independent software houses are "more responsive to user problems, more likely to enhance a product based on user requests and to have more efficient and easily implemented packages," a survey of users by F&S showed.

But users should be aware that when mixing a system, some risk is incurred over who accepts responsibility when a "crash" occurs, the report warned.

Software for word and manuscript processing packages, mainframe interface packages and firmware compilers are areas with promising market opportunity, the report found. Some of the most promising high-profit areas include general accounting, cash management and financial forecasting.

The report, "The U.S. Software Package Market Outlook in Small Business Computers," contains a directory of 180 minicomputer and 35 microcomputer packages plus 200 software suppliers. It is available for $900 from F&S Customer Service Department, 106 Fulton St., New York, N.Y. 10038.

Harris and Farinon Sign Merger Pact

MELBOURNE, Fla. — Harris Corp. and Farinon Corp. have signed a definitive agreement for the merger of Farinon into Harris.

Valued at about $130 million, the agreement calls for Harris to issue .8 share of its common stock for each of the 5 million outstanding shares of Farinon. The merger will be treated as a pooling of interests and will be tax-free to Farinon shareholders.

By acquiring Farinon's telecommunications products, Harris will gain an entry into the telephone industry market. Based in San Mateo, Calif., Farinon last year had sales of $93 million.

Wang Battling Shortage of CEs

LOWELL, Mass. — To ease a severe shortage of service technicians, Wang Laboratories, Inc. here initiated a career-oriented training program about a year and a half ago to recruit, train and retain customer engineers (CE).

The Service Technician Development Program, now completing its fifth sequence, recruits personnel from such sources as the Comprehensive Employment and Training Act (Ceta) programs, technical schools and the armed forces.

In selecting CE recruits, Wang looks for people who have had training or experience in electronics or computers, who have had some customer relations experience and who are interested in a long-term career with Wang. Students recruited to fill specific requirements become Wang employees on the first day of class, according to Richard Hebert, vice-president of customer engineering.

Wang has found local Ceta programs to be very helpful in providing recruits, many of whom had completed at least 900 hours of technical training in electronics or computer science and also met the customer relations prerequisite.

The students are housed locally and transported to the training center in Lawrence, Mass., where they spend a minimum of six hours a day in class listening to lectures and participating in laboratory demonstrations. Midway through the course, the students concentrate in one of two areas, computers or word processors. The type of course taken is determined at the time they are hired by the company, but cross-training will increase as the two systems come closer together, Hebert said.

The company estimated it invests nearly $10,000 in each individual. The success rate for the school has been high so far; of the five classes graduated, there have been only two "dropouts."

Program graduates are tracked to determine their individual proficiency as well as to provide a means of determining course effectiveness, Hebert noted.

Wang expects nearly 125 students to be trained over the next year. The number of recruits is closely linked to the booking of new orders so that a balance of CEs and equipment can be maintained.

FCC Approves Three Services

(Continued from CW/15)

countries, the commission said "no private leased line service has been discontinued or impaired" so far.

The FCC added that the services to Japan "might possibly fill a gap" in existing offerings by reducing costs for international private-line customers that don't need full-period service; therefore, "we have found it desirable to allow [the three services] to proceed . . . so that competitive forces could be the ultimate determinant of whether [they] should be provided."

The decision gives the protesting service bureaus (led by Control Data Corp. and General Electric Co.) some consolation, but not much. The three services are to be offered for one year, after which the commission can modify or terminate them.

The ruling indicates this will happen if the opponents can come up with "persuasive evidence" that private-line services are being cut back by foreign carriers.

Evidence to the Contrary

Although the FCC believes these services haven't been "impaired" to date, there is some impressive evidence to the contrary.

CDC spent 17 months trying to lease a full-period private line between its Lakewood, Ohio, computer center and Tokyo over which services resident on computers at this and other CDC sites in the U.S. could be provided to Japan. But the Japanese carrier, KDD, insisted the line could not be used as a relay point; it had to be terminated at a single computer within the Lakewood center — thereby sharply reducing the number of services CDC could offer.

This is one of several difficulties U.S. multi-national vendors of service bureau services have encountered during the past several years in trying to obtain private-line circuits in Europe as well as Japan. There's another side to the story, however.

As computer-based information services have become more popular, other countries — whose domestic suppliers tend to be less advanced than those in the U.S. — have worried more and more about the negative trade balance produced by buying computer-based systems and services from abroad. This revenue drain, plus concern about the privacy implications of storing sensitive data in foreign computers, has encouraged governments to restrict the U.S. incursion.

Moreover, foreign communications carriers, like those in this country, are investing heavily in new networks. But with a relatively limited market, many of them are finding it difficult to build an adequate customer base.

Borrowing customers from existing services is one solution. It's particularly appealing when the existing services involve leased private-line circuits priced way below their actual value to users with large data transmission requirements.

The result of these conflicting economic drives is an international controversy of substantial and growing proportions.

At press time, CDC and possibly other opponents of the FCC decision appeared likely to take it to court.

(Continued from Page 26)
extent that our ability to discern our involvements with either on a discreet basis will be increasingly lost. That services will command an increasing percentage of the dollars spent by our increasingly service-oriented society is doubtless, if for no other reason than that with increased intelligence comes less dependence upon purely physical solutions.

Basic to the force that's driving us to at least equalize our dependence both on products and services will be the creation of a more rational continuum between the two, providing a wider range of options to those who would avail themselves of either or both.

By 1990, institutional headquarters will have available to them many more options in how they conduct their affairs; the power to exercise these options will be limited less by external alternatives than by internal sophistication. With services carrying the same weight as products, not only will people-machine symbioses improve, but so will people-people symbioses.

Software Development

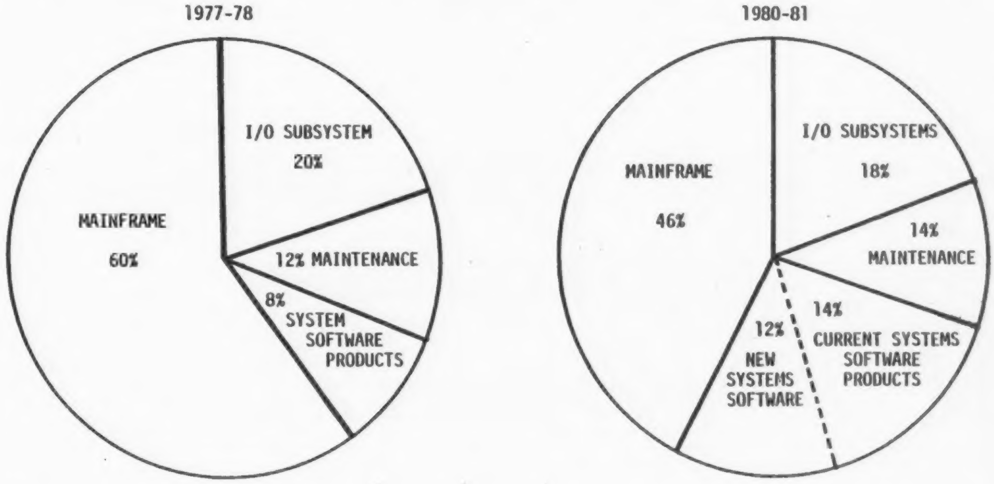
Fulfilling one very important role in our realization of the above admittedly utopian picture of our future will be the results of systems software and applications programs development. We have seen hardware technology produce

(Continued on Page 66)

CHART A

LARGE SCALE (2-3 MIPS) SYSTEM PRICE TRENDS

(For equivalent comparable systems)



NOTES: All pricing assumes purchase equivalent over a four-year period.

Mainframe includes: CPU, memory, standard features, channels, console and power distribution unit.

I/O subsystem includes: Central site devices only excluding communications equipment.

©ACT/TAG

Figure 1

(Continued from Page 65)
just about all we could use in power and sophistication in the latter '70s. We have seen the cost of this power plunge — there really have been enormous improvements in price/-performance even after inflationary considerations!

But exploitation of modern hardware is being sorely impacted by a critical shortage of software and applications technology. This should come as no surprise, for software and applications programs contain the code which allows the metamorphosis of heretofore purely manual processes into electromechanical and chemical media.

With increased distribution of computer systems power, there exists a proportional demand for personnel whose technical skills aid us in its exploitation. The actual trend has been quite the reverse. While there has been a net gain in systems analysts and programmers over the past few years, the rate of increase has diminished against the growth of demand, so that as we enter 1980 there is a severe shortfall of persons whose skills are sorely needed to create systems software and applications programs.

As we might expect, the countervailing forces vying for the supply of skilled technicians as their availability diminishes is one which puts the manufacturer of computer systems technology and users of this technology in severe contest. Figure 1 shows a current trend in systems software development in the total product offering for machines in the two to three millions of instructions per second (Mips) range in the large-scale systems price theatre.

It is anticipated that users will be paying an additional 14% for systems software products coming out of manufacturers' organizations in the 1980-81 time frame (which, as one may note, corresponds to an anticipated 14% reduction in hardware costs).

This should cause competitive manufacturing organizations who purvey systems of this size to raid the user marketplace for skilled personnel, resulting in an intensification of the critical skills shortfall problem. This may create a force that will drive users also competing for the same brainpower into a much heavier dependence upon outside service bureaus.

All this adds up to a very bright future for those service

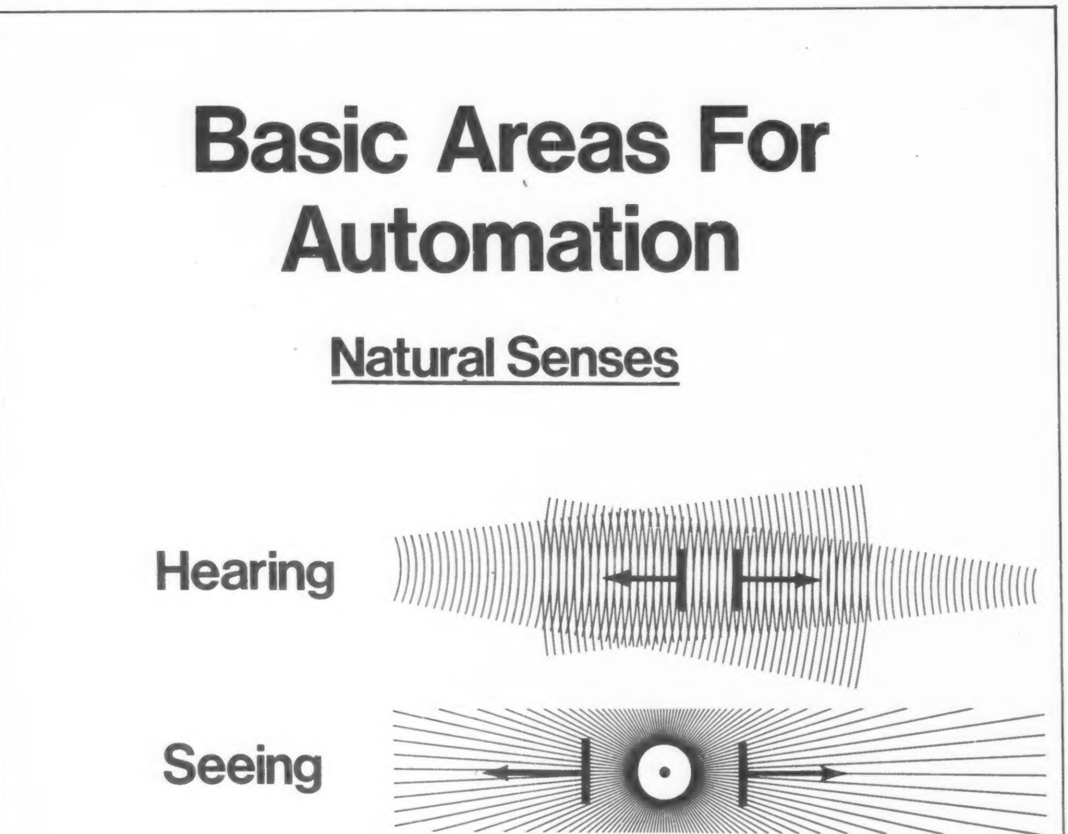


Figure 2

'The Boss Said I Think Just Like a Computer, So He Replaced Me With One.'

organizations that can remain viable in the 1980s, a period we've characterized as one of renaissance, complete with a spring rainshower of technological innovation.

Needless to say, this shower may increase in intensity at times to produce squalls and even hurricanes that will test the metttle of current service companies as they struggle for survival against their emerging "IBM-AT&T-ITT" competitors. Users, increasingly pressed to take advantage of the early 1980s technology flood, will switch the emphasis of their spending dollars from at-home development to service company employment.

And users will find that the large mainframe computer systems technology companies will be there waiting to satisfy their needs in increasing competition with the service company base that has thus far existed. The end result of all this should be an ebbing of the flood of innovation in hardware, a changing in the character of most of the large hardware-oriented electronic technology manufacturing organizations, increased competition with current service companies and a bonanza for persons skilled in creating systems software and applications.

Machine Superiority

By the year 2000, the emphasis will have shifted back to hardware products from the electronics technology community. By that time, we will have learned that in physical and intellectual performance, the machine can be far superior to the human being in almost every conceivable aspect. Mean-time-to-failure considerations alone will support this theory.

We will have learned that there is no virtue in human toil except as we may attach meaning to this idea. We will have learned that we hear but a very little of what may be heard and that our other senses are equally limited. And we will accept that we can recall but very little of what may be remembered and compute very little of what may be computed, and that our natural ability to operate in a purely logical fashion may be the most severely limited faculty we have.

Employing technology to extend our intellectual and physical senses will help us on the one hand, but the ultimate payoff will come in our acceptance of the notion that we are not what we *do*, so that we may as well get on to fulfill whatever other human promise there is.

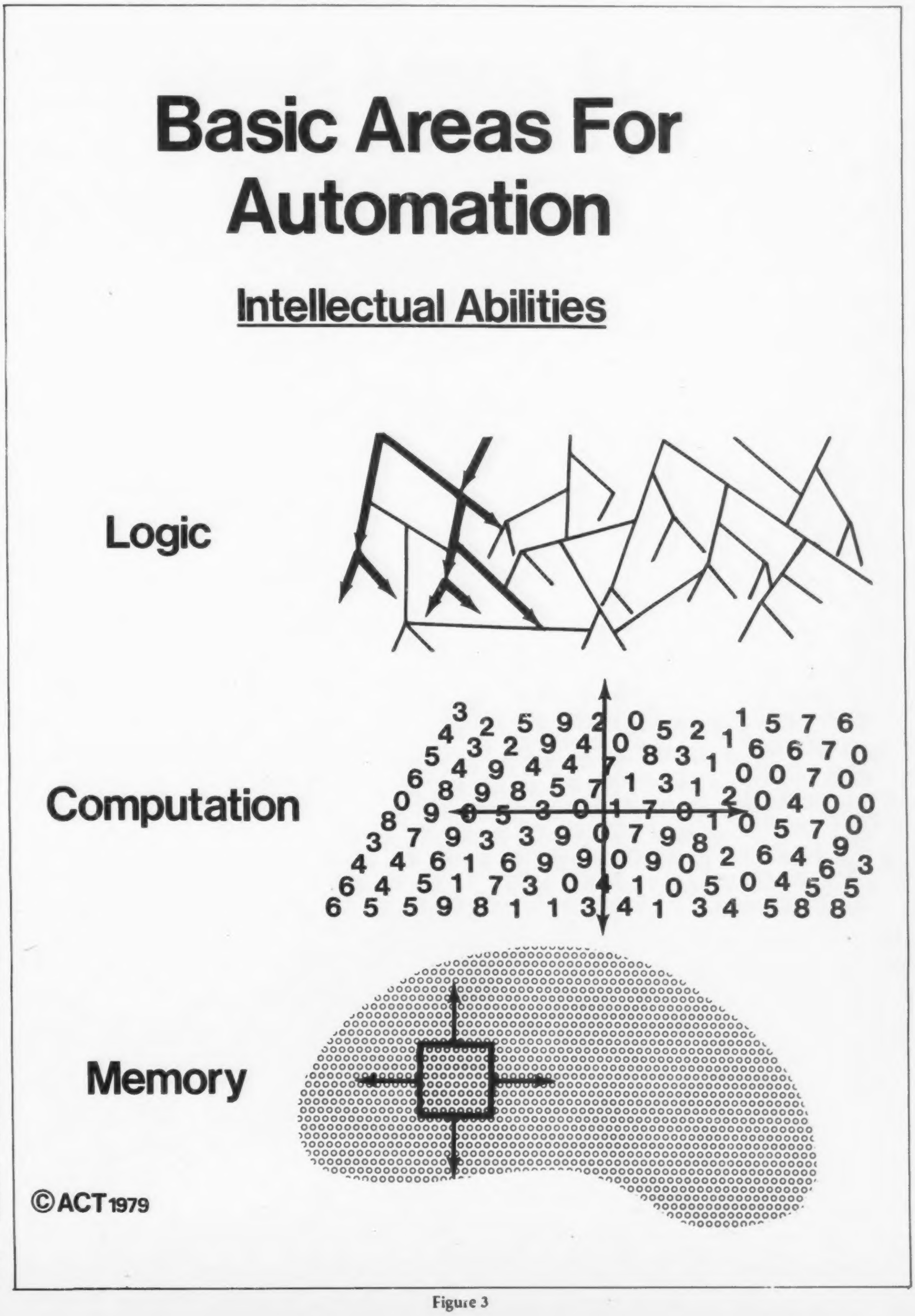


Figure 3

'Now That We Installed Your Computer, How Would You Like to Buy Our Computer Dictionary? Only $3,600 a Gross.'

(Continued from Page 5)

obstacle — which always exists five to 10 years before a future technological event becomes a reality — is the current question of what to do with 100,000 gate chips. This question will surely be solved early in the 1980s. One answer, to be hinted at later herein, is to put applications on a chip.

The Rub

But — and here is the rub — three new conditions arise for our rapidly changing field. First, the number of alternative applications possibilities of what to do with 100K-gate and later lM-gate chips is extremely large: computers-on-a-chip, smart-machines-on-a-chip, applications-on-a-chip, programs-on-a-chip, signal-processing-on-a-chip, compilers-on-a-chip, data management-on-a-chip.

Secondly, the design-development investment for each is huge, both in time and cost. But if more than a million copies are made of each, millions of dollars of development costs add only a few dollars to each copy.

Finally, the number of components of 100K-gate size, even in an elastic market, is quite a bit less (than previous chip components in the LSI and MSI ranges) for each design — but more in total for all usefully possible 100K-gate chip application designs.

When these three factors are combined, they suggest that VLSI, VHSI and BHSI (beyond VHSI) should have much longer lives than MSI and LSI hardware — both for their use in systems, as well as for their design viability life as a primary component of future systems.

Another forecastable obstacle, and perhaps the biggest problem area is the software problem — e.g., the stretchout in time imposed for the design of 100,000-gate chips, the computer-aided design (CAD) problem. That is, the pacing element is the catch-up game required by CAD developers and program developments to keep step with rapid semiconductor technology developments. Here again, if VLSI or VHSI truly turns out to have a longer life, so should the resulting CAD and operating system support systems.

With tens of thousands, hundreds of thousands and millions of logic gates per component, as with even a few thousand per chip, there

'I Realize You Consider This a Gross Computer Error, Mr. Thatcher, But We Here at the Bank Prefer to Think of It As an Act of God.'

are long design times. The component hardware for new computer systems for initial use early in the 1980s is therefore already on designers' desks.

Further, the design-development time for computers — large or small — is even longer. Computer systems for the early 1980s thus have already had their design cast on the prints. In fact, the time from the technology design inception of a new computer system to its first real usage and impact is well beyond five years, with common (or peak) usage not occurring until near the 10th year; by the 20th year, it still is a usefully viable system — and this time scenario is expected to grow longer.

Thus, interestingly, even in the face of an increasing pace of innovative developments in the underlying component technology, computer systems using such technology are tending to stay around longer as part of the technological fabric of society. This implies that (1) there is a considerable growth in the batching of computer function innovations, and (2) there are a growing number of technologically backward (but not necessarily obsolete) computer systems in use and more forecastable for the future.

For some applications, especially in colleges and universities, research and the military, the hardware in use is inadequate relative to what technological advances would allow to be available. For most others, perhaps the major number of applications, such computer systems using older (outdated?) technology are entirely adequate and even desirable from the viewpoint of the system stability.

But for the former applications, what is implied is a vast updating and revamping of computer systems for the mid-1980 decade or sooner. The successes from such computer developments will certainly impact all other areas of

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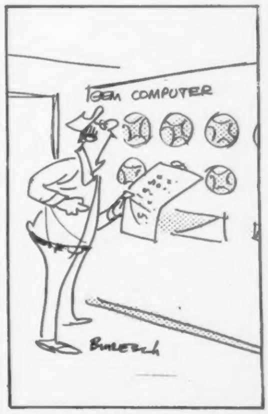


'Oh Yeah? Well I'll Tell You Something! I Liked the Personal Touch When I Had My Old Boss Who Came Around and Bawled Me Out Once in a While!'

SOCIAL PROBLEM	IMPACT ON FUTURE COMPUTER DESIGN	SOCIAL IMPACT OF FUTURE SYSTEM
Requires Experts	Convivial System	Friendlier and easer to use
Faults & Errors	Fault–Tolerant	Error–free operation
	Self–Repairable	
	Fail–Safe	
Unemployment Myth of Automation	Scenarios of Desirable Futures (from computer usage)	Opportunities to generate a higher QOL for society and more jobs
High Cost of Hardware and Software	Micro systems, VLSI/VHSI, Software cost in Hardware and Software Engineering	Lower cost computing – Displacement of people – Smarter computers and smart machines

Figure 1

(Continued from Page 69)
computing by creating more price/performance-effective computer systems.

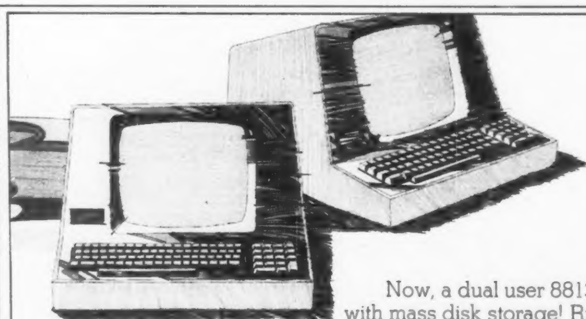
Thus, sometime in the 1980 decade, we must forecast a turning point in computer development leading to a new generation of computers, or at least a massive update. Such a turning point has already been initiated from the component viewpoint: it is the government's VHSIC program scheduled for first impacts in the 1983-85 time frame — with numerous computer developments expected to follow. This computer hardware technology advance is adding analog (signal processing, communication and sensor) circuitry side-by-side with digital logic and memory, resulting in an entirely new type of hardware for designers to design next-generation computers.

So, even though we must forecast that the computers of the early 1980s will (only) be evolutionary enhancements of present-generation computers, we also must forecast revolutionary computer developments for the latter part of the 1980 decade — but perhaps not until almost the 1990s, unless nontechnological factors speed up their introduction.

As computers become more automatically cybernating devices in the form of appliances for amplifying people, increasingly they will be called and characterized as "ethnotronic" — a word coined by Prof. Arthur M. Harkins from ethnic and (elec)tronic roots. Why? Such purposive appliances (tools for helping people) possessing communication capabilities, meshed with computer/cybernetic smarts, will establish a sort of ethnotronic culture. In such an electronic culture, people will communicate with appliances, appliances will trigger conversations with people to make the person they are amplifying "currently aware" and appliances will "talk" with other machines for the purpose of amplifying the person served.

Additionally, such amplifier appliances, in their own "cultural ways," will supply and support many other human needs by performing certain (broadly) information-related tasks themselves in order to perform their role within society.

Additionally, breakthroughs



in mass storage technology in the coming decade will see very large data bases become economically feasible for even small organizations — data bases that are orders of magnitude larger in capacity and at least an order of magnitude less costly. There is no doubt that drops of one to two orders of magnitude in mass storage costs will have profound business and societal effects: quicker movements into the information society, higher economic productivity, massive jumps into the paperless office of the future, real-time and life-long educational systems, knowledge- (instead of data-) based computer systems and much more, including business and society infrastructure changes.

Such advances in mass memory development are now clearly in store for the 1980 decade, and before 1990 we should expect even more.

Future-Generation

Instead of more exotic ways of performing mathematics, envision a branch of calculator evolution turning toward amplifying individuals in their profession via people amplifer devices or appliances. That is, consider identifying a small number of primitive functions — four, for example — unique to management that can be cast in hardware which is programmable (by a button and later via voice) like a microprocessor.

Consider also another four primitives which are unique to auditing or accounting or another group unique for the medical profession. For each case, a set of these primitives is built into the hardware of a hand-held device much like the modern calculator. Assume that they are instead called "people amplifier appliances," a different one for each profession.

Assume, alternatively, that besides a keyboard, the primitive functions and some sort of a simple electronic display, they also contain communications capability (e.g., can be plugged into the telephone), considerable writable memory capacity (for holding information and querying a data base equivalent to a number of books or a file cabinet) and a sophisticated electronic display. We would no longer refer to such sophisticated portable devices as an intelligent terminal; rather, they most likely would be classified as information appliances.

In either case, a multiplicity of appliances should hit the marketplace early in the 1980 decade, including smart management machines, smart doctor machines, smart reporter machines, smart voter machines, smart senator machines, smart programmer machines, smart designer machines, smart artist machines, smart teacher machines and smart student machines.

Each would become "smarter" (evolve) through the addition of more primitives every three or so years. That is, many waves of evolutionary

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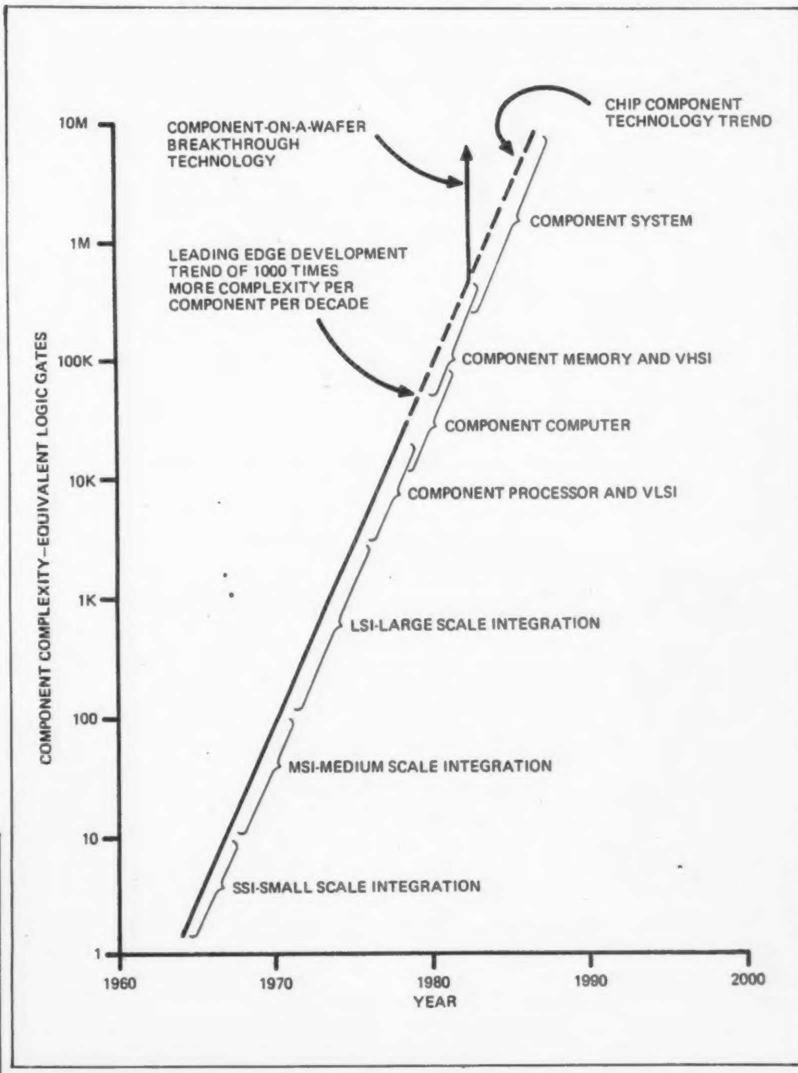


Figure 2: Computer/Micro Complexity Trend — Component Computers

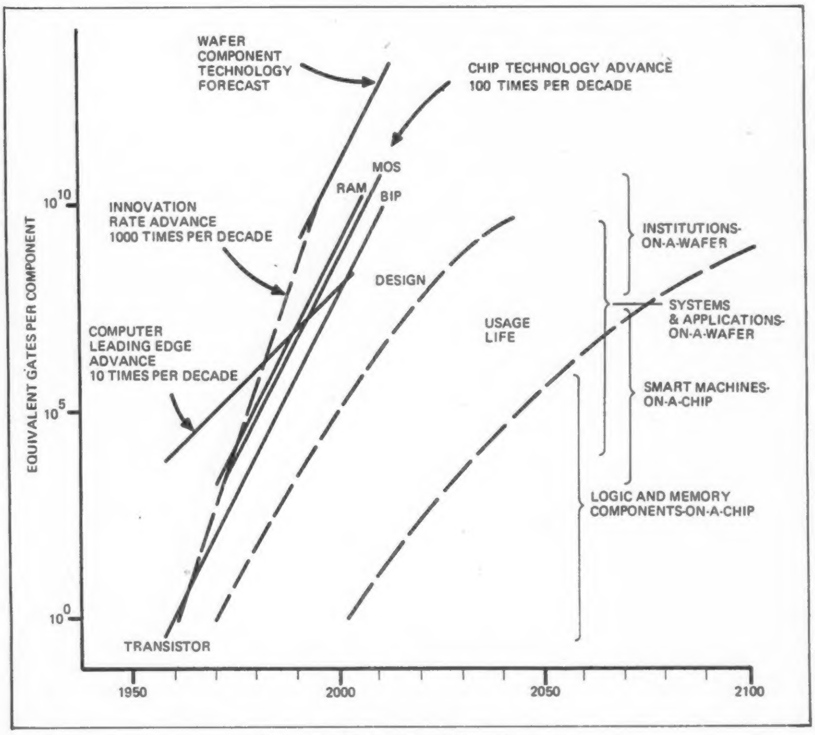


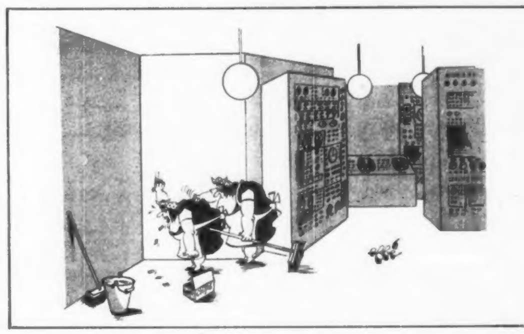
Figure 3: Silicon Revolution Forecast

(Continued from Page 71)
developments (generations) of such smart appliances would be sprung upon the marketplace. Ultimately, the market for such people or information appliances will total billions of appliances.

As people appliances change toward information appliances, the need grows for larger and larger "centralized" computers or, at the very least, very large and smart data bases. Macros will be needed to "feed" such micro appliances with updated information. Thus, the more little ones (the information appliances) that society uses, the more big ones (next-generation more or less classical computers) will be required.

Office-of-the-Future

Much has been recently written about the electronic office, the office of the future. Some such offices now exist and others are being planned; many new options for the office of the future are developing, with many more expected on the future horizon for the 1980s. Thus, the "office-scape" of the future can now be forecast going through a number of eras or generations



as the future springs forth, somewhat mappable as shown in Figure 4.

In the mapping of the probable future of the office of the future, the later trends of management information services (MIS)-on-a-chip/wafer or the office-of the-future-on-a-chip/wafer will bring about a "component information system" or a "component office" which can be embedded into other machines to make them smarter.

In Figure 5, some mid- to late-1980s and 1990s purposive ethnotronic people amplifier appliances and systems are noted. Obviously, each will start out as primitive embodiments and grow in capability as new versions enter the marketplace.

By the close of the 1990s, these ethnotronic systems should become extremely capable and drastically alter the infrastructure of society. Therefore, because we can now forecast major changes in society occurring as a result of developing future computer systems, their developers and their future users must make an early study of their expected impacts and consequences so society can be prepared to accept them into opportunities, rather than problems.

1 – WORD PROCESSING (WP) – MINICOMPUTER BASED
2 – SMART WORD PROCESSING – MICROCOMPUTER BASED
3 – COMMUNICATIONS ORIENTED WP
4 – WP AND DP MARRIAGE
5 – INTEGRATED WP-DP-MIS-DB-DBMS
6 – COMPUTER MAIL AND COMPUTER CONFEREN CONFERENCING
7 – SMART OFFICE MACHINES – PEOPLE AMPLIFIER APPLIANCES
8 – SMART OFFICES
9 – INFORMATION APPLIANCES
10 – KNOWLEDGE BASED MACHINES
11 – REMOTE OFFICES
12 – MIS-ON-A-CHIP/WAFER
13 – OFFICE-OF-THE-FUTURE-ON-A-CHIP/WAFER.

Figure 4: Some Possible Office-of-the-Future Generations

Computer Future Histories

From these foregoing technological developments, the pace of the computer's impact upon business and society is expected to quicken in the 1980s.

Some new directions in microsystem technology resulting in new cybernetic computer machine developments are:

- Smart machines
  - Smart computers
  - Smart office, factory, educational and transportation machines
- People amplifier appliances
  - Para-expert amplifier adjuncts
  - Smart management, doctor, lawyer, auditor, teacher, etc. appliances
- Component computers
  - Computers-on-a-chip
- Applications-on-a-chip/-wafer
  - MIS-on-a-chip
  - Payroll-on-a-chip
  - Order-processing-on-a-chip
- Information appliances
  - Smart-office-of-the-future-on-a-chip/wafer
  - Remoteable offices, schools
- Smart memory
  - Very low-cost mass memory
  - Smart data base memory/computer
- Knowledge-based systems
  - Libraries/file-cabinets-on-a-chip
- Very large-scale distributed computers (but physically small)
  - Distributed DP almost everywhere.

A basic premise is: Semiconductor silicon technology continues to advance sufficiently fast enough so that for the 1980s and beyond, computer developments will continue to emerge and bring:

- Less costly systems.
- More capable computer sys-

(Continued on Page 74)

ETHNOTRONIC SYSTEMS — SOLID STATE CULTURE

1ST GENERATION	2ND GENERATION
SMART MACHINES	SMART SYSTEMS
BOOK-ON-A-CHIP	OFFICE-ON-A-WAFER
MIS-ON-A-CHIP	SCHOOL-ON-A-WAFER
COURSE-ON-A-CHIP	LIBRARY-ON-A-WAFER
DOCTOR-ON-A-CHIP	FACTORY-ON-A-WAFER
MANAGER-ON-A-CHIP	INSTITUTION-ON-A-WAFER
TEACHER-ON-A-CHIP	FUTURE WORLD(S)-ON-A-WAFER
POLITICIAN-ON-A-CHIP	CULTURES-ON-A-WAFER

PEOPLE AMPLIFIER APPLIANCES

Figure 5: The Silicon Revolution

(Continued from Page 73)
tems.

- More reliable, fault-tolerant and self-repairable computer systems.
- Easier to use computers which are convivial.
- Physically smaller computers for embedding into things to make them smart.
- More computer functionality.
- Amplification of people computers.

Further, these desirable impacts from computer technological developments can come at a faster pace for the 1980s than they have been emerging in the 1970s decade.

In the 1980s, the technological microengines of social change that allow smart machines will be the tiny silicon chips containing on their surface tens to hundreds of thousands to millions of very fast circuits in submicron geometries and later the use of total wafers for componentizing total applications, systems and much more. By embedding such microengines of extreme logic complexities into common machines, and at their interface with humans, future technological systems will spark an era of an advanced convivial symbiosis with humans and the surrounding environment, which is automatically simple in application. All of this will come with continually plummeting prices and with progressively increasing functionality and performance capabilities.

Such declining prices will allow these microengines of change to become commonly available; with their convivial enhanceabilities (through embedding of complexity to make the resulting systems easy to use), the total world will benefit — rich or poor, expert or novice, educated or educationally deprived . . .

Impact of Advances

Such visions of this desirable turning point in computer technological developments and the future it implies are now possible to realistically extrapolate for fruition in the 1980 decade, from evolutionary extensions of the leading edge of today's technology. In peering through the maze of future technological trends and social forces at work, rapidly advancing evolutionary change will look in retrospect like radical revolutionary change when viewed over a 10-year or longer time span, especially as future computer developments allow computers to pass into new (lower) levels of affordability.

As previously stated, the

'For My Birthday, Dad Gave Me a Basic Computer — a Pencil and a Paper.'

current revolution in computers is measured in chips, microns and nanoseconds, with the microengine of change being the tiny but highly integrated circuit silicon chip. Soon, silicon parameters are headed toward wafers, submicrons and picoseconds as the technology pushes toward VHSI.

Although such parameters are important to semiconductor manufacturers and computer designs, what do they mean to the typical businessperson? The future impact of such hardware advances on computer systems, for the coming decade, can be forecast and summarized as follows:

- More reliable systems
  — Fault-tolerant and self-repairable
- Easier to use systems
  — Smart computers
- Data base computers
  — Smart memories
- More processing options
  — Application-adjunct processors
- More software cast in hardware
  — Application primitives — programs cast into hardware
- "Knowledge-based" systems
  — Integrated decision support systems
- More distributed systems
  — Smart distributed DP
  — Smart machines
- More computer networks
  — Data communications
  — Computer mail and computer conferencing
- Next-generation(s) office of the future
  — Greatly improved office productivity
  — Smart offices
- Computer-on-a-chip as a reality
  — Component computers
  — Embedded component for smart systems
- Lower cost systems and functions
  — Historical change rate continued
- More software engineering
  — Lower cost and more timely programs
- Smart management (etc.) machines
  — Next-generation calculators
  — Smart people amplifier appliances
- Portable information appliances
  — Smart computer terminals/communicators

And certainly there will be many other developments.

Revolution or Evolution

Will the energy crisis and the current recession impel us to stay with existing technologies longer? Or will technological advances create their own economic forces for leaping faster to the new technologies rather than slow down technological advance?

One consideration that already emerges is very obvious — forecasted advances in device technology will drastically alter the options in the 1980s. VLSI techniques now in their infancy are already changing design options for the near-term future, further causing possible dramatic improvements in the functionality, quality and cost reduction (in the per-function) realms.

Additionally, analog circuits are being integrated with logic and memory on the same chips, giving designers a totally new component for revolutionizing computers later in the 1980 decade.

Already designs for 1980-era cars are incorporating semiconductors as well as entering the office and factory machines for increasing the

(Continued on Page 76)

'Any Place They Speak Fortran?'

(Continued from Page 75)
productivity of energy — and for making the resulting machines smarter.

If the energy crisis continues and the cost of fuel escalates, as is forecast for the next 10 years, there is little doubt the advanced computer technological developments outlined here will play an increasingly major role in society for enhancing the way we use energy. Such a trend will speed the use of advanced computer and computer technology developments.

Conversely, as we move more deeply into a depressed economy, many pressures will surface to slow technology developments in some areas, but speed them up when such technology advance can ease the cost scenarios.

Software Cast Into Hardware

Throughout the history of computers, as each new wave of machines emerged, a growing number of (parts of) programs were put into the hardware architecture, creating a "hard software" trend. Before the early 1950s, most computers didn't have the sequenceable and combinational primitive instructions wired-in, such as multiply and divide. And for many programmers, like myself in my early career, much effort was spent in the programming of multiply and divide.

Then, in the first generation of computers, these primitives were wired into the hardware, and programmers were released from such tasks allowing them more time for the application programming effort than for controlling and manipulating the "tool."

The historical map and the extrapolation of the trend of putting programs into hardware unfolds as "eras of hard software" such as:

- First hard software generation — early 1950s
  Instruction/computational primitives — e.g., multiply and divide
- Second hard software generation — 1960s
  Algorithmic primitives — e.g., indexing, floating point, trig functions and square root
- Third hard software generation — 1970s
  Language/control primitives — e.g., executive control primitives, I/O primitives, high-level language primitives, microprocessor primitives and system primitives.
- Fourth hard software generation — 1980s
  Application primitives — e.g., peopleware primitives, professional primitives, accounting primitives (payroll) MIS and courseware primitives
- 1985 (After)
  General system primitives
- 1990s
  Institutional primitives and robotic primitives

In most cases, for the 1980s, the future primitives for hard software will (1) be incorporated as part of the hardware architecture of computers or "calculator" devices; (2) be cast as an optional adjunct for attachment to a computer system, memory, a calculator or to an information appliance to make them smarter, or otherwise (3) become a stand-alone, special-purpose machine — for example, a "payroll machine" or an "electronic file cabinet."

Sometime towards the mid- to late 1980s, smart people/information appliances could well become the major interface to computers, data bases, information bases and knowledge-based systems.

Concluding Remarks

Future computer technology is forecasted to cause an economy-of-scale flip-flop. That is, as computers and other machines become smarter, more computer power will become remoted to local machines and to aid individuals.

Further, these same technology trends are forcing computers of all classes to be physically small and to be cast from the micros. Thus, the micro era computers initiated in the 1970s will grow in the 1980 decade and the trend away from macrosystems to microsystems will continue.

In this coming era, components will become end products, computers will become components, ethnotronic people-amplifier computer appliances will become common and schools, offices and factories will become machines (made from component com-

'A Bit Excessive, This One, Eh, Jenkins?'

puters). For the latter, vast energy savings are possible; therefore, such a future largely depends upon the course that the energy crisis takes in the 1980s.

After the 1980s, perhaps early in the 1990s, when multiple systems are integrated onto wafers, we may again see a macro era of computers (but not from the physical size viewpoint).

Does all this mean the demise of large, centralized mainframes? Most likely it does not. Trends are now indicating that the more computer power put at remote sites, the more computer power that is required at central nodes — to support both traditionally centralized functions and to support the remote/distributed systems and devices, such as people amplifiers and the carried information appliances.

Thus, even in the 1980 decade, we can forecast a growth in macrosystems. In fact, we might label the very late 1980s as the rebirth computer age of the macrosystems, as we are labeling the 1970s the microsystem era. As hardware costs continue to drop and more computer functions are put on a chip or wafer, business, science and society will have the opportunity to tackle much larger problems with computers.

Many of the social aspects (taboos and forbidden zones) that currently exist are apt to still exist in the next decade (in respect to the use of "older computer systems") together with many new ones (in respect to the emerging ethnotronic systems).

Does this imply that DP people and management will have less to do, or even be phased out? Most certainly not — except for certain application areas.

Why? First of all, for those applications that we learn to almost completely automate, and thus cast into hardware, DP personnel and management will largely not be required. But because computers will become smaller, considerably less costly, more functional, more capable and more reliable, they will be in more widespread usage and, therefore, need more support services and create more applicability into both smaller and bigger application areas — all pointing toward the need for more DP personnel and management.

But, needless to point out, future DP management will be increasingly displaced and the task will be considerably altered. Even so, a bright future for DP management is forecastable, especially in an environment of cohabitation with friendly computers.

In the final analysis, future computer developments, by the late 1980s and thereafter, are going to present many alternatives. Many, if not most, of the computers now in use will still be running, alongside many follow-on (evolved) versions. Additionally, new computers, both larger and smaller (in capability) types, which are considerably smarter and more cost-effective will also be proliferated.

But perhaps the most prevalent computer type in the later 1980 decade will not even be called a computer — it will be a type of "component computer" embedded in other machines to make them smart and easier to use — and thus "computers" could become the nuts and bolts of systems.

(Continued from Page 9)

higher level protocols. This will continue to cause difficulties for the end user in resolving the industrywide incompatibility problems.

Carriers will continue to encroach upon the traditional DP-oriented functions of the mainframe and minicomputer suppliers. To counter these thrusts, the data processing industry will continue to try to develop ways to maximize its options involving dependencies upon the common carriers. One of the primary means of salvation for the end user who could potentially be caught in this cross-fire will be the influence of standards, with which both carriers and DP vendors will be forced to comply.

New Services

Teleconferencing will become extremely fashionable and widely used. Skyrocketing energy costs plus satellite technology will join forces to produce new and improved private and public networking offerings enabling meetings to be held without moving the participants around.

By 1983 or 1984, the debate between full-motion video and freeze-frame will be moot. Instead, participating vendors will utilize satellite facilities to offer a full menu of bandwidth and scanning rates allowing users of teleconferencing services to select the most appropriate offering which they can afford.

In conjunction with these teleconferencing offerings, public and private data networks will be widely utilized to support large amounts of document and data transfer capability so people can exchange information in these electronic meetings, in much the same way they do when all parties are brought together at a central meeting site today.

Office of the Future

The documents which are transferred in conjunction with these services will come from a wide variety of peripherals, such as those shown in Figure 2. Essentially, every business machine we have in our offices today will become a potential candidate for interconnection to the intelligent networks of the middle 1980s.

In addition to application development productivity problems in the computer industry, productivity problems in the office will receive at least as much attention in the communications offerings of the 1980s. Potential payoffs for firms capable of developing turnkey solutions to at least a partial set of the office automation functions are mind-boggling.

As the figure indicates, the equipment within the office of the future will be interconnected on a physical premise, and this site will effectively constitute a node for the corporation-of-the future network. Interfaces to a broad mixture of public and private network services will have to be provided.

There will be broad overlaps of functional capability involving the front-end processors, computerized branch exchanges and the supercontrollers. All will be concerned with making it easier for people to communicate, regardless of whether they utilize a telephone, a document transfer machine, a traditional computer terminal, CPUs or a management workstation terminal.

Integration Process

Actual integration of voice, data and administrative communications will progress very gradually over the first few years of the next decade. All forward-looking organizations will state a desire to develop a corporate telecommunications utility capable of interconnecting all the diverse types of business machines shown in Figure 2.

Total integration would imply a technology enabling fully dynamic sharing of all the local wiring, local switching and intercity transmission facilities. I do not see this happening until the latter part of the 1980s at the earliest. Even then, I doubt if the technology will be completely available to provide this type of networking utopia!

We must not underestimate the amounts of money which large vendor

(Continued on Page 80)

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organizations coveting a piece of this business are going to spend. In the U.S. alone, there will be probably eight or 10 extremely well-financed large corporations going after different pieces of the business which we have been discussing. In order to penetrate these markets, many new kinds of products will be introduced, including highly sophisticated and advanced computerized branch exchanges, operating in conjunction with the supercontrollers shown in Figure 2.

It is very obvious from this diagram that many of the major suppliers of the office of the future will need to have the capability for tying together all of their different terminal devices, data bases, local switching and application software.

The dynamics of this technology transfer will continue to further amplify the people problems which exist in the industry today. There are acute shortages of individuals capable of understanding the consequences of these new technology developments and ap-

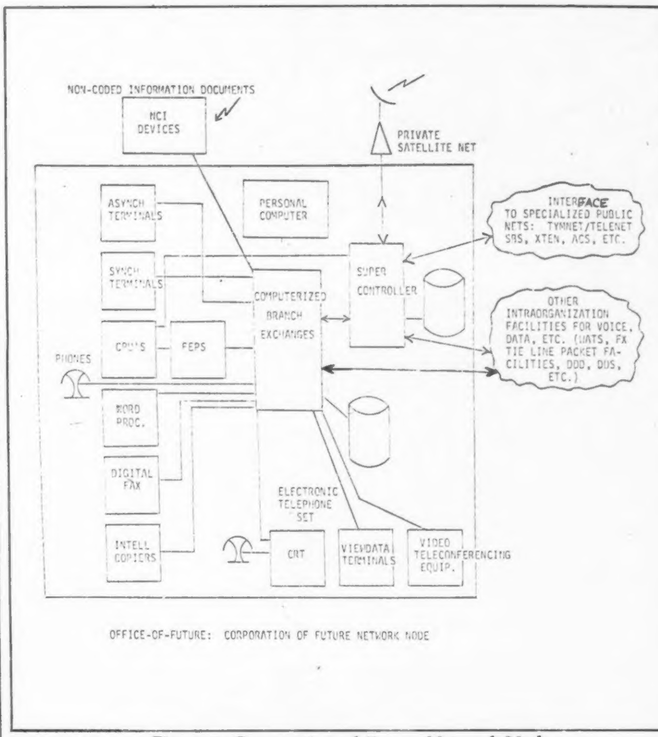

Figure 2: Corporation-of-Future Network Node

plying them to the practical solution of business problems within organizations today.

There will continue to be much organizational confusion within corporations throughout the 1980s. Gradually, however, top management will begin to realize the huge payoffs associated with deploying an advanced corporate telecommunications networking capability. They will realize that, in order to exploit these potential opportunities, telecommunications' position within the organization will have to be elevated.

Executives concerned with managing key corporate assets will fast recognize that telecommunications and data base resources will be two of their enterprises' most valuable assets. The corporate mentality will shift away from the "bricks and mortar" philosophy to emphasize asset value in telecommunications and data base areas. The emphasis on rapid decision-making, reduced travel expenditures and the need to coordinate activities of many individuals in diverse locations will all provide driving forces for the continued communications enhancements which we have been describing.

Summing Up

The communications environment of the 1980s, then, will witness major services not available today. These services will involve mixtures of satellite transmission, packet switching, fast circuit switching, electronic mail and advanced switching vehicles (computerized branch exchanges) with supporting software to automate the application development functions and the overall operations of offices.

The corporation of the future will be tied together with an extremely advanced mixture of networks and services. Some of these will be private networks; some will be public networks.

Computer vendors and the common carriers will continue to sharpen up their strategic positions to do battle with each other and obtain a piece of the action in the enormous markets which will continue to unfold.

Standards efforts will continue to plod along and offer users at least partial hope for a more straightforward resolution of the incompatibilities which have plagued us during the '60s and '70s.

In the 1980s, the communications industry will begin to mature. No longer will the management of this extremely vital resource be taken as lightly as it has in the past. However, people shortages and improperly structured organizations will continue to impede the realization of many of the benefits of the new services of the '80s.

Computer vendors will continue to refine the layered networking architectures which virtually all introduced in the '70s. However, the attendant complexity of many of these offerings and the restrictions imposed by their initial implementations have resulted in lower than anticipated acceptance by the user marketplace; we can expect this to change significantly in the '80s as the benefits of these layered architectures begin to be more readily identifiable.

The opportunities for corporations to exploit many of the new service offerings will be enormous, both in terms of lower unit costs for voice, data and administrative communications and also in terms of providing completely new kinds of services. However, developing the optimal configuration of services, switching equipment and terminal devices to meet the fast-changing spectrum of requirements will be more difficult than ever before.

Traditional analysis and configuration techniques will quickly become useless. Corporations operating without strategic plans for telecommunications will find themselves increasingly vulnerable and incapable of responding to changes. No one in this business can be sufficiently clairvoyant to forecast all the significant developments which are going to occur. However, we have attempted to provide insight into those major developments most likely to occur in the 1980s and to emphasize the urgency of organizing now in order to exploit the advantages which they promise.

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Others developed ad hoc reports via simple report generators, such as RPG III or Easytrieve. And some companies used preprocessors such as Metacobol to raise a machine-independent language to a higher level.

The experience of many companies that have used such systems has shown that the number of statements to be written, debugged and maintained using a generative system vs. standard Cobol can be reduced by a ratio of at least 10:1. These packages demonstrated that the cost of programming could be reduced significantly through generative systems.

High-Level Programming

Another method of reducing the cost of program development was to design the system at a "higher level" for the user. By the end of the 1970s, there was a greater awareness that the machine-independent languages, such as Cobol, PL/I and Fortran, were not keeping pace with the changing DP world.

The new DBMS and teleprocessing requirements, the high cost of maintenance, the shortage of programmers and the accelerating costs were important forces that pushed the introduction of high-level programming systems. Some of these high-level programming systems include the new languages that are embedded in data base/data communication systems, the preprocessors to existing compilers, and the interactive terminal-oriented programming systems.

As the 1970s end, there are new combinations of these systems appearing. All of these high-level systems are designed to be user-friendly, easy to use, forgiving and able to reduce the cost of both programming and maintenance.

Cobol's Viability

In the 1960s, while Cobol was the most widely used language, PL/I was heralded as the new "language of the 1970s" by IBM. The special user-oriented programming languages such as RPG III, Mark IV, Work 10, Score, Adpac and others were equally heralded as the replacements for Cobol.

As Mark Twain said, "The announcement of my death is premature." Likewise, Cobol continued to grow and flourish in the 1970s, despite its verbosity and clumsiness. Therefore, a significant development of the 1970s must be considered the ability of Cobol not only to survive as a language, but to grow and get stronger as the predominant language of the commercial user.

According to recent *Guide and Share* surveys, about 80-90% of all commercial installations use Cobol as its predominant user language. Of course, in the 1970s there was a great number of Cobol programming aids that were developed to complement the Cobol compiler. These were in the form of Cobol preprocessors, Cobol testing programs, Cobol optimization programs and Cobol documentation aids. In total, they have made Cobol the king — albeit an unpopular one — of the commercial languages.

User-Friendly Languages

While Cobol reigned supreme during the 1970s, a significant number of terminal languages also gained high acceptance among users. Initially developed to prompt terminal users, the new languages are being used today for data entry, on-line queries, programmer and end-user training, job scheduling, JCL preparation and, unfortunately, computer games.

Experience with these languages has shown that they increase terminal user productivity by easily managing repetitive tasks, by being menu-driven and by reducing input errors. They have also proven to be another means of increasing programmer productivity through their ability to create macro commands that can be executed by the touch of a single key on the keyboard or a single, typed command.

Most are interpretive and permit simple interactive debugging and complete integrity during execution. These user-friendly terminal languages will continue to gain in power and use during the 1980s.

Structured Programming

Whatever the language used, the need for an organized, structured and modular approach to program design, coding and testing became the cry of the 1970s. Structured programming (SP) is a philosophy, a technique and a language.

As a philosophy, it had its roots in the 1960s through a wide variety of training and design methodologies, as well as articles criticizing the undisciplined method of computer programming. It was the *Datamation* December 1973 issue that popularized SP as a technique.

Dijkstra and others, in a series of articles, books and letters, defined the three basic pseudo-language control structures: "sequence" (a series of one-entry, one-exit statements), "loop" (Do . . . Until) and "decision" (If . . . then). Unfortunately, no Cobol, Fortran or PL/I compilers could process the SP pseudo-language, and the use of pseudo-language required a manual translation to the particular language desired.

While several companies were successful in developing SP machine translators through Cobol, Fortran, PL/I precompilers or the Assembly macro facility, the actual application of SP by most companies in the 1970s was shamefully poor. Part of the failure was a result of the difficulty of retraining programmers to accept the long-term benefits of SP. This was compounded by the desire of management for short-term benefits and paybacks.

SP faced other problems as well. The DP industry neglected to define and

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standardize the SP language. In addition, IBM and other manufacturers promoted the benefits of SP, but did not provide a machine translation from "pseudo-code" to Cobol or another language. This created a great deal of disappointment for many companies that did experiment with SP.

On the other hand, controlled user experiments have shown that SP can significantly reduce the costs of programming, maintenance and enhancements. SP will, therefore, undoubtedly play a very important role in the 1980s by providing more reliable programming systems.

Programming, Maintenance Costs

In spite of the varied approaches to programming in the 1970s, inroads were made to the cost of programming and maintenance. While hardware costs today are declining at a faster rate than programming costs, it is a fact that the cost of programming in the 1970s declined significantly.

The productivity of programmers through the use of programming aids and software packages produced amazing results for many users. Based on numerous surveys, the number of man-years to code, debug and maintain programs is significantly less today than in the 1960s. While this assertion may be questioned, consider the complexity of the applications and their costs in the 1970s. Developing comparable applications in the 1960s would have been considerably more expensive.

The cost of maintenance also decreased. In the early 1970s, it was estimated that 50% of all programming was for maintenance; by the mid-1970s, maintenance was estimated to account for 80% of the programming cost. By the late 1970s, however, some companies saw the cost of maintenance for new applications reduced to the 30% range through the proper use of data base, data dictionaries, documentation aids and other programming tools.

Commercial Applications

In the 1970s, many companies were heavily dependent on their software and their computers, but it was their innovative commercial applications that often gave them a competitive business and marketing edge. Those companies valued and nurtured their commercial application developments as if they were the company's treasured jewels.

For example, such applications were often the key to communication networks, customer service, processing of orders, calculating complex competitive bids, lowering manufacturing and production costs, reducing raw material waste and inventory control and ordering.

Thus, critical applications for those companies contributed to their growth and success.

For others, commercial applications created a whole new set of problems. For every successful application development effort, there was at least an equal number of failures.

In the 1970s, software — regardless of whether it was from the software package house, the hardware manufacturer or the user — became a very important "piece of property" and a valuable asset that required legal protection.

The 1970s witnessed three Supreme Court patent rulings, a three-year congressional Contu committee copyright study, numerous software sales tax state hearings and a multitude of papers and debates on how to define software in order to protect it. There is strong evidence indicating that software should be treated in a manner similar to hardware and that the current patent, copyright, trade secret, Internal Revenue Service, tax, accounting and other laws are applicable to software.

The application of existing laws to software has generated vigorous debates focusing on the nature of software and its tangibility vs. intangibility. What is not controversial is that the 1970s demonstrated the importance of software and the need for software to be fully protected. Certainly, the 1970s clearly established that "free" and "public domain" software is a thing of the past.

Software Surge

As suggested earlier, unbundling was the catalyst that unleashed a great deal of software technology into the computer scene. In fact, the full impact of the software surge has not yet been completely absorbed in this 10-year period. Undoubtedly, many of the still unprofitable software developments of the 1970s will reap their rewards in the 1980s.

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In retrospect, IBM and the other hardware manufacturers can "scream to the moon" that the bundling of the 1960s was a natural marketing approach toward providing a full service. The facts are that their "free" software in the 1960s inhibited the growth and actual emergence of the software products industry and was a great disservice to the user community.

While the legality of bundling in the 1960s is still being questioned in the courts in the 1970s, it is undeniable that this decade benefited from unbundling. Perhaps the greatest outgrowths of the decade are as follows:

• *Software competition and innovation:* There was virtually no software innovation in the 1960s; the 1970s, on the other hand, had hundreds, if not thousands, of examples of innovative software. And, during the 1970s, there were a great number of independent software companies and hardware companies competing for the software dollar.

Unlike the 1960s, when a user had no choice but to use a "free" piece of software, the 1970s provided the DP manager with an important alternative: he could buy a package of his choice in the software product marketplace. This competitive environment has stimulated and encouraged a great deal of software technology innovation during these past 10 years and will continue in the 1980s.

• *Improved quality and reliability of software:* With increased software product competition, the quality, as well as quantity of software products rose significantly in the 1970s. While there is still a long way to go, the reliability of today's commercial applications are also significantly higher than in the 1960s.

This reliability can be attributed to the availability of program testing aid packages, improved operating system reliability and considerably greater discipline in the software design, development and maintenance phases. Obviously, increased reliability results in cost savings and more effective use of corporate resources and assets.

• *The superiority of the "independents'" software:* By focusing all their efforts on software, the independent software companies proved in the 1970s that they could build software that was superior to that of the hardware manufacturers — despite such roadblocks as a lack of early hardware and software specifications and plans.

For the last six years (1973-1978), the Datapro Research Corp./*Datamation* user survey continued to rate the independent software company packages significantly higher than hardware companies' packages in the important areas of overall satisfaction, ease of use, documentation, support and efficiency. There appears to be nothing on the horizon to alter this trend in the 1980s.

Thus, in the 1970s, IBM and the other manufacturers were dethroned as the only software "game in town." The prudent software buyer of the 1970s could buy his software from any of a great number of vendors. Unbundling proved the vitality, strength and benefits of a free enterprise system. It provided the leverage for a user to demand quality software and quality service.

Furthermore, unbundling allowed small companies to grow, to innovate and to provide the buyer with a clear choice at a competitive price. Perhaps that was the most important software event of all in the 1970s.

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SURVEYING THE '70s AS WE ENTER THE '80s

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work architectures conform to concepts similar to those embodied in the reference model. However, little agreement among vendors occurs above Levels 2 or 3. Thus, while the X.25 standard has been widely adopted for packet-switching systems, this standard addresses only the first three levels.

Furthermore, there are today at least six incompatible implementations of X.25. Thus, while standards emerged during the last decade, much work is needed before one even remotely resembling a universal standard is possible.

One of the most exciting developments of the last few years has been the emergence of the value-added network (VAN). A VAN can be distinguished from a classical common carrier because it does not build transmission facilities. Instead, it leases conventional common carrier facilities and combines them with specialized message-processing services which add "value" to the network.

VANs currently operating within the U.S. include GTE Communications Corp.'s Telenet, Tymshare, Inc.'s Tymnet and ITT's Faxpak. Both Telenet and Tymnet provide data communications service while Faxpac currently serves facsimile terminals. ITT's plans include extension of Faxpak services to data communications in the future.

Until recently, users thought of networks as transparent channels that simply accommodated bit streams from origin to destination, with all special features incorporated as the endpoints of the network. Thus, if the user wished to add an error correction scheme to protect his data, he built it into the processors or front ends.

Similarly, a code conversion scheme would be built into the sources and destinations. By using minicomputer switches, a VAN introduces this service into the switching nodes so the network is no longer a transparent device.

The VAN gives the user a ready-made backbone network (a resource which might be too expensive to be developed independently by the small user). Thus, the user's network problem then becomes one of achieving access to the VAN through the appropriate interfaces and his own local distribution network.

Distribution of VAN access locations relative to the user's locations determines the size and cost of the user's local distribution networks; if the VAN has many access locations, the local network may be quite limited. Thus, a VAN's attractiveness varies with its growth in geographical coverage, even though its tariffs do not change.

Today's VANs offer access ports in more than 150 cities within the U.S. Currently, most data service is for low-speed (up to 1,200 bit/sec) asynchronous terminals. Synchronous service on a limited basis is now available and, within the next few years, could be widespread. However, today's VAN represents only a minimum resource compared to the data communications utility requried by tomorrow's user.

New Carrier Services

Another important recent development is the emergence of domestic satellite carriers which, because of technological economics, can offer attractive tariffs, especially for higher volume users. Using current satellite technology, ground stations tend to be somewhat expensive and are usually supplied by the satellite carrier on a shared basis. This tends to limit their role in the local access area.

On the other hand, satellites can substantially reduce the cost of backbon-

Physical Layer (Level 1)
Provides Mechanical, Electrical, Functional and Procedural Characteristics to Establish, Maintain and Release Data Circuits Between Link Entities.

Link Layer (Level 2)
Provides Functional and Procedural Means to Establish, Maintain and Release One or More Data Links Between Two or More Network Entities.

Network Layer (Level 3)
Provides Functional and Procedural Means to Exchange Data Between Two Transport Entities, Independent of Routing and Switching Considerations.

Transport Layer (Level 4)
Provides Reliable, Cost-Effective, Transparent, Location-Independent Transfer of Data Between Session-Processing Entities.

Session Layer (Level 5)
Supports Dialogue ("Session") Between Cooperating Application Entities.

Presentation Layer (Level 6)
Provides Services to Allow Application Processes to Interpret the Data Exchanged by Managing the Entry, Exchange, Storage, Retrieval, Display and Control of Structured Data.

Applications Layer (Level 7)
Provides Distributed Information Service for End User, Application Management or System.

Figure 5: Ansi/ISO Protocol Reference Model

communications given sufficient data requirements. In particular, the cost of high-data-rate satellite channels is substantially lower than their terrestrial equivalents.

During the last two years, much talk and space in trade journals and newspapers has been devoted to the "new" offerings of Satellite Business Systems, Xerox's Extended Telecommunications Network and the Advanced Communications Service of AT&T. At the end of the decade, these offerings shared several similarities and many differences.

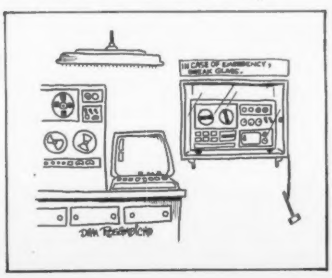
The major similarities include lack of tariffs for user analysis, lack of believable (or any) dates for initiation of service and the nonexistence of the basic networks and equipment needed to support the services. In light of these similarities, we will have to postpone discussion of the differences until a forthcoming review article on the decade of the 1980s.

Meanwhile, while we wait for and talk about the above system, other new carriers such as MCI, Southern Pacific Communications Corp. and American Satellite Corp. (ASC) continue a process begun several years ago to offer low-cost voice services (e.g., MCI's Execunet) or enhanced data communications services (such as ASC's Satellite Data Exchange). Recent progress by these organizations holds much promise for future services.

The birth of modern data communications occurred during the last decade. With it emerged many options and even more challenges to adopt the new technologies to user needs.

Today's users *believe* that today's networks provide high system reliability, widespread equipment compatibilty, support for a variety of terminals, easy connections to host computers, effective network management, control, diagnostic and repair capabilities and adaptability to varying traffic types and conditions.

The challenge of the 1980s will be to convert this belief into a reality.



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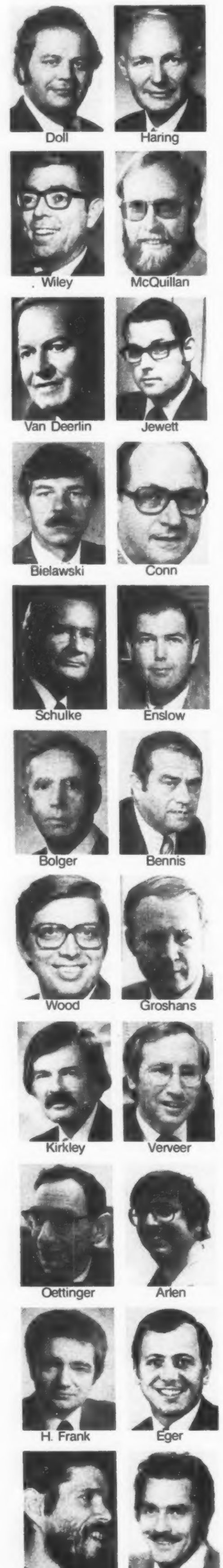
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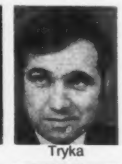
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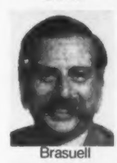
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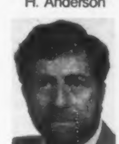
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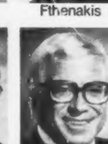
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Henry Geller, Assistant Secretary for Communications and Information/National Telecommunications and Information Administration/U.S. Department of Commerce
Harry M. Shooshan, III, Associate Counsel/House Subcommittee on Communications/House of Representatives
Herbert Jasper, Executive Vice President/Ad Hoc Committee for Competitive Telecommunications
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Ronald A. Frank, CN'80 Technical Program Director
Prof. Ithiel de Sola Pool, Director, Center for Policy Alternatives Massachusetts Institute of Technology
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Frank Vigilante, Project Director, Advanced Communication Service/AT&T Business Marketing Dept.

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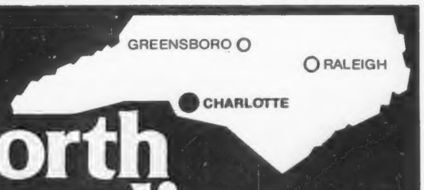

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The Methods and Models Group provides modeling and evaluation services to Digital's engineering and marketing organizations. Our involvements encompass product conceptualization, setting product performance goals, evaluating design tradeoffs, predicting performance throughout design and development phases, and developing methodologies/models for configuring, sizing and tuning customers' systems.

We seek professionals with PhD or equivalent experience in Computer Science/Operations Research/Electrical Engineering, with specialization in computer performance analysis. Necessary assets include: • in-depth knowledge of operating systems • good understanding of hardware • outstanding problem-solving capabilities • results orientation • strong oral and verbal communication skills. Knowledge of Digital products is desirable.

Measurement and Analysis

This group analyzes the performance of systems and subsystems (Digital vs Digital and Digital vs competition). We provide empirical performance measurements and statistics using Remote Terminal Emulators or software, hardware and hybrid monitors, providing performance services to both internal and external customers. Current involvements include:

- **Systems Performance and Analysis**
- **Subsystems/Peripheral Performance Studies**
- **Competitive Studies and Analysis**
- **Applications Efficiency Studies**

Candidates should possess: • BS/BA or MS in Computer Science or equivalent experience • working knowledge of operating systems • understanding of performance tools/methodology.

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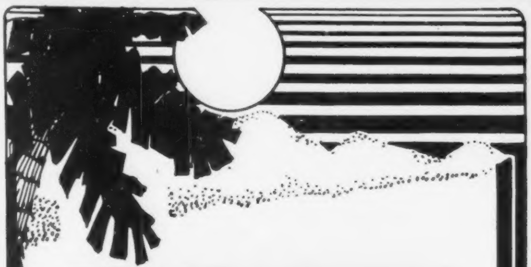

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Directs, coordinates and participates in the selection, generation and maintenance of technical computer software on a medium to large-scale computer system. Provides expertise in hardware selection and utilization. Acts as a functional manager or supervisor of other systems programmers. Provides technical direction to Ames Laboratory scientific staff by suggesting solutions to complicated and technical programming problems and by advising on program logic. Coordinates systems programming activities with scientific personnel and computation services staff. Qualifications required are B.S. or equivalent in Computer Science with 7 years programming experience including 3 years systems programming experience on a medium to large scale system. Must have thorough kowledge of the capabilities and limitations of current generation, multiprogramming computer systems and of software including operating system theory. Also, must have extensive assembly language programming, experience on more than one vendor's computer system, FORTRAN programming experience, and knowledge of structured programming techniques.

Applicants should submit complete resume along with names and addresses of three professional references to:

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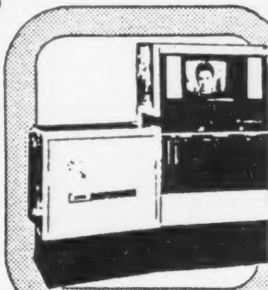

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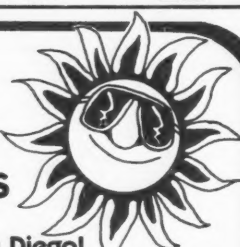

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800-525-8258/303-773-1313

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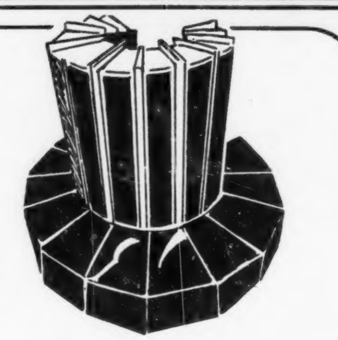

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1-305-942-5870 9-5 Mon-Fri

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Software engineer experienced in compiler design and development, writing of operating systems, and systems support software for software systems design and development in airborn anti-submarine warfare signal processing applications. Experience with implementing PASCAL on 16-bit microprocessor-based systems would be exceptionally useful. Should not be adverse to writing enhancements, modifications and update to systems software provided by outside vendors of in house sources. Languages must include extensive PL/1 and FORTRAN, and PASCAL or some other block structured language. IBM or DEC operating systems background helpful.

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Software or Electrical Engineer with strong background in use of minicomputers in signal processing, Kalman filtering, Fast-Fourier transforms, and other similar applications, preferably in military signal processing. Should have experience in assembly language programming, writing structured programs using top-down techniques, and software documentations. Should be familiar with IBM and DEC operating systems.
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Computer Department
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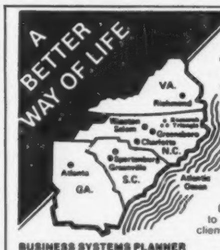

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Scientific Applications Programmers
Develop and support computer aided design and interactive graphics applications. Experience with IBM 370, minicomputers, COBOL, FORTRAN, PASCAL, data base management, numerical methods and structured programming preferred.

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SYS3/CCP des. mfg. apps. Ala.	To22K
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Career Associates, inc.
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No. Dartmouth, Mass. 02747

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Position requires two years experience in design of computer applications. Experience using Honeywell 6000 level 66 series, supervisory capabilities and good communications skills desirabel. Excellent salary and fringe benefits. Send resume in confidence to:

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Bismarck, North Dakota 58501

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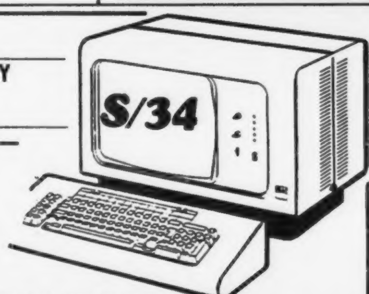

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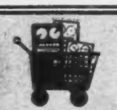

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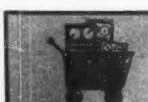

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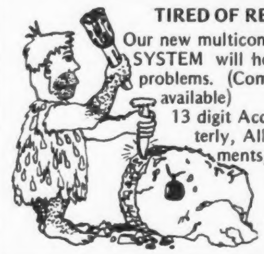

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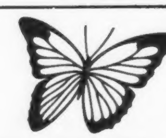

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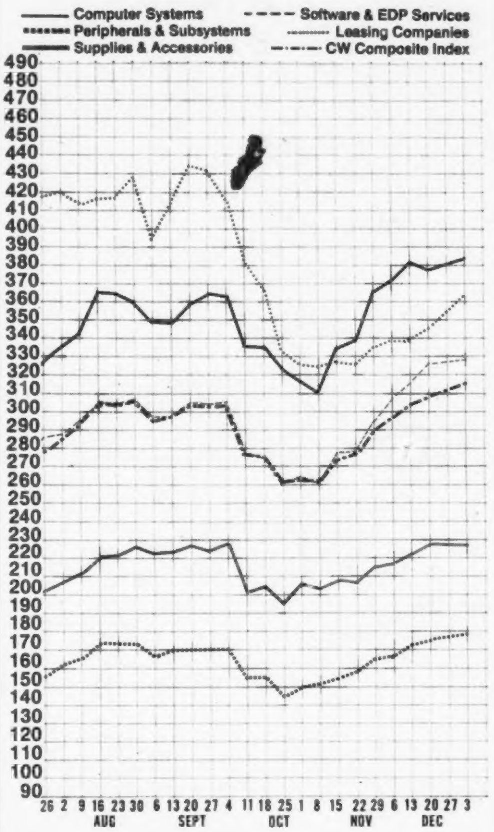

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TRADE QUOTES

Computerworld Stock Trading Summary

CLOSING PRICES WEDNESDAY, DECEMBER 26, 1979

All statistics compiled, computed and formatted by TRADE QUOTES, INC. Cambridge, Mass. 02139

EXCH		PRICE 1978-79 RANGE (1)	CLOSE DEC 26 1979	WEEK NET CHNGE	WEEK PCT CHNGE
	COMPUTER SYSTEMS				
A	AMDAHL CORP	17- 69	24 3/8	- 7/8	-3.4
N	BURROUGHS CORP	59- 87	80	-1	-1.2
O	COMPUTER AUTOMATION	9- 44	12	+ 1/2	+4.3
N	CONTROL DATA CORP	23- 57	54 1/8	- 3/4	-1.3
O	CRAY RESEARCH INC	8- 51	46 1/2	+1 3/4	+3.9
N	DATA GENERAL CORP	42- 74	53 5/8	+ 5/8	+1.1
N	DATAPOINT CORP	34-105	103	+1 3/8	+1.3
N	DIGITAL EQUIPMENT	39- 69	67 1/2	+ 1/2	+0.7
N	ELECTRONIC ASSOC.	2- 13	7 1/4	+ 1/2	+7.4
A	ELECTRONIC ENGINEER.	9- 19	16	- 1/4	-1.5
N	FOUR-PHASE SYSTEMS	19- 46	44 1/4	0	0.0
N	FOXBORO	28- 44	39 1/2	+ 1/4	+0.6
O	GENERAL AUTOMATION	7- 26	16 3/8	+ 3/8	+2.3
O	GRI COMPUTER CORP	1- 3	1/2	0	0.0
N	HEWLETT-PACKARD CO	24- 63	58 3/4	- 7/8	-1.4
N	HONEYWELL INC	43- 85	82 3/4	- 3/8	-0.4
N	IBM	62-321	64 7/8	+ 1/2	+0.7
O	MANAGEMENT ASSIST	9- 29	18 7/8	- 3/8	-1.9
O	MANUFACTURING DATA S	9- 38	37 1/2	+2 1/4	+6.3
O	MINI-COMPUTER SYST	2- 8	2 3/4	- 1/4	-8.3
O	MODULAR COMPUTER SYS	7- 18	13 1/8	+1 3/4	+15.3
N	NCR	37- 81	69 3/4	- 3/4	-1.0
N	PRIME COMPUTER INC	9- 23	23 1/4	+ 5/8	+2.7
N	PERKIN-ELMER	17- 42	41 1/8	+1 3/4	+4.4
N	SPERRY RAND	33- 52	50 1/4	- 1/8	-0.2
A	SYSTEMS ENG. LABS	11- 24	19 3/8	+1 1/4	+6.8
O	TANDEM COMPUTERS INC	13- 41	39 3/4	+ 3/4	+1.9
A	WANG LABS.	6- 32	30 1/2	- 1/8	-0.4
	LEASING COMPANIES				
O	BOOTHE FINANCIAL CP	13- 21	16 3/4	- 1/4	-1.4
O	COMDISCO INC	3- 21	13 1/2	+ 1/4	+1.8
A	COMMERCE GROUP CORP	1- 1	3/8	+ 1/8	+50.0
A	COMPUTER INVSTRS GRP	1- 7	2 1/8	0	0.0
O	CONTINENTAL INFO SYS	3- 15	3 1/2	+ 1/4	+7.6
N	DATRONIC RENTAL	1- 4	2 3/8	- 1/8	-5.0
A	DCL INC	3- 6	5 1/4	0	0.0
N	DPF INC	8- 14	8	+ 1/8	+1.5
N	ITEL	4- 36	5 5/8	+ 3/8	+7.1
N	LEASCO CORP	24- 60	56 3/4	-1 5/8	-2.7
O	LEASPAC CORP	1- 4	1/8	0	0.0
A	PIONEER TEX CORP	2- 7	2 5/8	0	0.0
N	U.S. LEASING	12- 20	15	0	0.0

EXCH: N=NEW YORK; A=AMERICAN; P=PHIL-BALT-WASH
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O-T-C PRICES ARE BID PRICES AS OF 3 P.M. OR LAST BID
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EXCH		PRICE 1978-79 RANGE (1)	CLOSE DEC 26 1979	WEEK NET CHNGE	WEEK PCT CHNGE
	SOFTWARE & EDP SERVICES				
O	ADVANCED COMP TECH	1- 2	7/8	0	0.0
O	ANACOMP INC	8- 24	17	- 3/4	-4.2
O	ANALYSTS INTL CORP	3- 5	4 3/4	+ 1/8	+2.7
A	APPLIED DATA RES.	8- 17	9 3/4	- 3/8	-3.7
N	AUTOMATIC DATA PROC	24- 40	36 1/8	- 3/8	-1.0
O	COMPU-SERV NETWORK	5- 18	18	0	0.0
O	COMPUTER HORIZONS	1- 9	5	- 1/4	-4.7
O	COMPUTER NETWORK	5- 16	6	- 1/4	-4.0
N	COMPUTER SCIENCES	8- 20	18 1/2	- 5/8	-3.2
O	COMPUTER TASK GROUP	1- 7	6 3/4	0	0.0
O	COMPUTER USAGE	2- 4	2 1/8	0	0.0
O	COMPUT AUTO REP SVC	4- 10	5 3/4	0	0.0
O	COMSHARE	6- 26	19 1/4	- 1/4	-1.2
O	CULLINANE CORP	14- 33	29 1/2	0	0.0
O	DATA DIMENSIONS INC	1- 9	2 1/8	0	0.0
O	DATATAB	1- 4	1 1/8	+ 1/8	+12.5
O	DSI CORP	4- 6	6 1/4	0	0.0
N	ELECTRONIC DATA SYS.	15- 28	27 1/8	0	0.0
O	INSYTE CORP	1- 3	1 3/4	0	0.0
O	IPS COMPUTER MARKET.	2- 3	3	0	0.0
O	KEANE ASSOCIATES	3- 6	6	0	0.0
O	KEYDATA CORP	1- 4	4	0	0.0
A	LOGICON	10- 20	18 1/8	- 1/8	-0.6
O	NATIONAL DATA CORP	7- 17	15 1/2	+ 1/4	+1.5
N	PLANNING RESEARCH	4- 10	6 1/8	+ 1/4	+4.2
O	PROGRAMMED TAX SYSTS	3- 5	4 1/4	0	0.0
O	PROGRAMMING & SYS	1- 1	7/8	+ 1/8	+16.6
O	RAPIDATA INC	3- 7	5	+ 3/4	+17.6
O	REYNOLDS & REYNOLD	18- 36	24	- 1/4	-0.8
O	SCIENTIFIC COMPUTERS	3- 11	9 1/2	- 1/2	-5.0
N	TYMSHARE INC	18- 54	51	-1 7/8	-3.5
A	URS SYSTEMS	5- 10	9 1/4	+ 1/4	+2.7
N	WYLY CORP	1- 7	6 1/8	+ 3/8	+6.5
	PERIPHERALS & SUBSYSTEMS				
N	AM INTERNATIONAL	13- 32	14 5/8	- 3/8	-2.5
N	AMPEX CORP	10- 20	19 7/8	- 1/8	-0.6
O	ANDERSON JACOBSON	5- 16	15 7/8	+2 1/8	+15.4
N	APPLIED DIG DATA SYS	6- 22	8 3/4	- 1/8	-1.4
O	AUTO-TROL TECHNOLOGY	14- 36	35	+2	+6.0
O	BEEHIVE INT'L	3- 7	4 3/4	- 1/4	-5.0
A	BOLT,BERANEK & NEW	8- 19	17 3/8	- 3/4	-4.1
N	BUNKER-RAMO	10- 29	27 7/8	+ 5/8	+2.2
O	CAMBRIDGE MEMORIES	1- 9	2 1/4	- 1/8	-5.2
O	COMPUTER DEVICES INC	5- 8	8 3/8	+ 1/2	+6.3
N	CENTRONICS DATA COMP	16- 54	51 3/4	+4 5/8	+9.8
O	COGNITRONICS	1- 4	2 3/8	+ 1/8	+5.5
O	COMPUTER COMMUN.	6- 10	6	+ 3/4	+14.2
O	COMPUTER CONSOLES	4- 29	18 1/2	-1	-5.1
A	COMPUTER EQUIPMENT	3- 6	5 3/4	+ 3/4	+15.0
O	COMPUTER TRANSCEIVER	1- 5	3 3/4	0	0.0
O	COMPUTERVISION CORP	5- 56	56 3/8	+4 1/2	+8.6
N	CONRAC CORP	13- 26	17 1/4	+ 1/4	+1.4

EXCH		PRICE 1978-79 RANGE (1)	CLOSE DEC 26 1979	WEEK NET CHNGE	WEEK PCT CHNGE
A	DATA ACCESS SYSTEMS	0- 10	10	+ 1/8	+1.2
A	DATA PRODUCTS CORP	13- 25	20 1/4	+ 7/8	+4.5
O	DATUM INC	2- 6	2 3/8	0	0.0
O	DECISION DATA COMPUT	2- 6	2 5/8	- 1/8	-4.5
O	DELTA DATA SYSTEMS	1- 1	3/4	0	0.0
N	DOCUMATION INC	6- 34	15 5/8	-1 3/4	-10.0
O	DATARAM CORP	6- 35	33 3/4	+1 1/2	+4.6
N	ELECTRONIC M & M	3- 9	3 1/2	0	0.0
O	EVANS & SUTHERLAND	20- 42	38 1/2	0	0.0
O	FABRI-TEK	1- 2	1	0	0.0
O	GENERAL COMPUTER SYS	1- 3	2	+ 1/8	+6.6
O	GENERAL DATACOMM IND	9- 24	23 1/2	+1 3/4	+8.0
N	HAZELTINE CORP	10- 21	20 5/8	+ 1/2	+2.4
N	HARRIS CORP	17- 36	33 1/8	- 1/4	-0.7
O	INFOREX INC	1- 11	1 7/8	+ 5/8	+50.0
O	INFORMATION INTL INC	7- 12	8 3/4	0	0.0
O	INFOTON	1- 3	2 1/4	- 1/8	-5.2
O	INTEL CORP	26- 72	68 1/4	+ 3/4	+1.1
O	INTERSIL	7- 32	25 7/8	-1 1/8	-4.1
A	LUNDY ELECTRONICS	4- 8	6 5/8	0	0.0
O	MSI DATA CORP	6- 19	8 5/8	- 1/8	-1.4
N	MEMOREX	17- 59	18	+1	+5.8
N	MOHAWK DATA SCI	6- 17	16 1/2	+ 7/8	+5.5
O	OMEX	2- 8	8 1/2	0	0.0
O	PARADYNE CORP	9- 27	26 1/8	+2 1/8	+8.8
A	PENRIL CORP	5- 14	13 5/8	+ 1/4	+1.8
A	POTTER INSTRUMENT	2- 2	1 3/4	0	0.0
O	RAMTEK CORP	7- 14	12 1/2	- 1/8	-0.9
O	RECOGNITION EQUIP	5- 13	6 5/8	0	0.0
O	SCAN DATA	1- 5	1 5/8	+ 1/8	+12.5
N	STORAGE TECHNOLOGY	14- 46	17	- 5/8	-3.5
O	SYKES DATATRONICS	4- 20	21 1/2	-1 1/4	-5.4
O	T BAR INC	11- 26	25 1/4	+1 1/4	+5.2
A	TEC INC	6- 13	5 1/2	- 1/4	-4.3
N	TEKTRONIX INC	33- 63	60 5/8	- 5/8	-1.0
N	TELEX	3- 9	3 7/8	0	0.0
O	TESDATA SYSTEMS CP	8- 26	11 3/4	+ 1/2	+4.4
O	TIMEPLEX INC	4- 11	10 3/4	- 3/8	-3.3
O	WILTEK INC	1- 2	1/4	0	0.0
	SUPPLIES & ACCESSORIES				
A	AMERICAN BUS PRODS	6- 12	11 3/8	- 1/4	-2.1
O	BALTIMORE BUS FORMS	1- 4	1	0	0.0
N	BARRY WRIGHT	14- 34	22 3/4	- 1/2	-2.1
O	CYBERMATICS INC	1- 1	7/8	+	+7.6
O	DUPLEX PRODUCTS INC	13- 31	25	-1 1/2	-5.6
N	ENNIS BUS. FORMS	5- 21	17 1/4	+ 1/2	+2.9
N	3M COMPANY	43- 66	49 3/4	- 1/4	-0.5
O	MOORE CORP LTD	26- 36	29 1/2	- 3/4	-2.4
N	NASHUA CORP	18- 37	29 3/4	-1 3/8	-4.4
O	STANDARD REGISTER	20- 29	26 3/4	+ 1/4	+0.9
A	TAB PRODUCTS CO	8- 19	18 3/8	+ 1/4	+1.3
A	WABASH MAGNETICS	10- 22	14 1/4	- 1/4	-1.7
N	WALLACE BUS FORMS	18- 33	28 7/8	+ 1/4	+0.8